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FINAL
FOCUSED FEASIBILITY
STUDY REPORT

CROYDON TCE SITE
BUCKS COUNTY, PENNSYLVANIA

SEPTEMBER 1988
W.A. NO. 124-3LM7

EBASCO SERVICES INCORPORATED EBASCO

One Oxford Valley, Suite 414, 2300 Lincoln Highway - East, Langhorne, PA 19047-1829, (215) 752-0212

September 23, 1988
RM/III/88-0551
N/A

Mr. Jeffrey B Winegar
Environmental Protection Agency
Region III
841 Chestnut Street
Philadelphia, PA 19107

Subject: REM III PROGRAM - EPA CONTRACT NO. 68-01-7250
CROYDON TCE SITE, BUCKS COUNTY, PENNSYLVANIA
FINAL FOCUSED FEASIBILITY STUDY REPORT

Dear Mr. Winegar:

Enclosed are six (6) copies of the Final Focused Feasibility Study (FFS) Report for the Croydon TCE Site. This FFS has been prepared in accordance with EPA Region III's request in place of a "standard" FS. This Final FFS has incorporated the EPA comments submitted to the REM III Team on August 3, 1988. Attachment A provides a listing of these comments along with the REM III Team's responses.

Following the Phase II remedial investigation, the REM III Team will submit a "standard" FS which addresses all environmental media at the Croydon TCE Site. The subject FFS only addresses an alternate water supply and in-house treatment of groundwater for those residents who are not serviced by a public water supply and are affected by contaminated groundwater. The No Action Alternative is also evaluated for comparison purposes.

If you have any questions or comments regarding this report, please feel free to call me or our Site Manager, Mr. Raymond P Wattras, at 412-788-1080.

Very truly yours,

Richard C Evans
Richard C Evans, P.E.
Regional Manager, Region III

RCE/RPW/drp

cc: S Del Re - EPA (w/o enclosure)
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File: W.A. No. 124-3LM7 (621Y/553)
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ATTACHMENT A

RESPONSES TO EPA COMMENTS ON THE DRAFT FOCUSED FEASIBILITY STUDY

Comment No. 1:

On page 4, it is unclear why the contaminant level of TCE at the exposure point be reduced to below 5 µg/l (the MCL). EPA Headquarters recently stated that the most pertinent ARAR clean-up level is the MCL, if it exists for the chemical of interest.

Response:

> This sentence has been revised to state that contaminant levels will be reduced to "acceptable levels," which in this case would be to 5 µg/l or lower.

Comment No. 2:

On page 17, it is stated that lead was detected above health-based standards and that it appears to be unrelated to the ground water contamination associated with the site. It should be also stated here that elevated levels of lead may be attributed to household plumbing or well systems containing lead piping or copper water piping with lead/tin solder jointed fittings. In addition, the point at which sampling is done on private wells is not specified in the FFS, therefore, this issue may or may not be of concern.

Response:

> A sentence has been added to indicate that the presence of lead may be due to the plumbing. The sample was taken directly from the holding tank.

Comment No. 3:

Table 1-2 does not mention the detection of 1,4-dichlorobenzene in residential wells, however, it is listed as a chemical of concern in Table 1-3.

Response:

> This table has been revised; however, 1,4-dichlorobenzene is no longer listed as a chemical of concern in Table 1-3 since it was only detected in 4 out of 40 residential wells and at a maximum concentration of 0.20 µg/l.

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Comment No. 4:

In Table 1-1, we are concerned about possible elevated levels of 1,2-dichloroethane in private wells. We also remain concerned about the presence of benzene at possibly elevated levels.

Response:

> 1,2-Dichloroethane was detected in 4 out of 40 residential wells at a maximum concentration of 3.3 µg/l. The MCL for this contaminant is 5 µg/l. Only 1 out of 40 residential wells exhibited benzene (3.8 µg/l). Benzene was detected in only one <u>monitoring well</u> at a concentration of 0.4J µg/l.

Comment No. 5:

Also in Table 1-3, if 4,4-DDT and dieldrin are chemicals of concern in the ground water, why are they not mentioned in Table 1-1? In addition, there is no MCL for 1,4-dichlorobenzene as Table 1-3 suggests.

Response:

> Table 1-1 has been revised to include dieldrin and 4,4-DDT. The contaminant 1,4-dichlorobenzene is no longer listed as a contaminant of concern due to the low levels (and limited frequency) detected in the wells. The MCL identified for this contaminant was an error.

Comment No. 6:

In Table 1-4 on page 28, why is the Hazard Index for the ingestion of ground water <1 for the future case and >1 for the current case? Is this correct?

Response:

> This table has been revised to depict the current case as <1.

Comment No. 7:

On page 30, it is stated that "this feasibility study does not address the remediation of ground water" (i.e., pump and treat). Even though the pump and treat alternative would most likely be selected as the remedial action alternative, it should not be implied here as the selected alternative for ground water remediation.

Response:

> This sentence has been revised. "Pump and treat" has been deleted.

Comment No. 8:

The Bristol Borough Water and Sewer Company is not an Authority. This system has previously failed to monitor for organic and inorganic chemicals as required by SDWA and may still be in violation. The quality of water provided by this system should be examined. Bristol Borough is supplied by one intake on the Delaware River and 3 wells. None of these sources are near the site or likely to be within its scope of influence.

Response:

> All references to "Authority" have been removed from the text. Prior to submitting the Draft FFS, we requested and received an analysis of both their intake water (from a well) and their treated effluent. The intake water, which is supplied by wells in Edgely, exhibited elevated levels of TCE and PCE (approximately 10 µg/l). The treated effluent did not exhibit these contaminants above the method detection level. The results were presented as <0.5 µg/l for both of these contaminants.

Comment No. 9:

The applicability of the "rules of thumb" and selection of the driving GAC demand factor for the equations determining filter unit parameters (Appendix A) is questionable, considering the characteristics of this ground water. It appears that the levels of solids and interfering compounds such as sulfate are high enough to significantly affect the performance of the filters.

Response:

> High levels of suspended solids would definitely interfere with granular activated carbon adsorption by blocking the active sites of the media and rapidly fouling it, which would require much more frequent unit backwashing than is practicable. It is, however, questionable whether the maximum TSS value of 415 mg/l shown on Table 3-1 is representative, as this sample was taken from an inactive residential well. Active residential wells have shown TSS readings of less than 10 mg/l and it is our experience that most people will not routinely use water containing more suspended solids as it is objectionable to sight and will not fulfill its cleaning purpose. At this level of suspended solids, the "rule-of-thumb" of 10 pounds of granular activated carbon per pound of TOC is not unreasonable.

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Dissolved sulfates, especially at concentrations of 86 mg/l or less, will not interfere with granular activated carbon adsorption. Other sulfur compounds such as sulfides may compete with organic compounds for adsorption, but not sulfates.

Comment No. 10:

Why are not all of the chemicals of concern appearing in Table 1-3 for residential wells, included in the sampling program for those limited number of residential wells west of the plume?

Response:

Table 1-3 has been revised to reflect the chemicals of potential concern that were identified in the Final RI Report (see Table 5-11 of the Final RI Report). Based on the revised list of critical contaminants, wells located west of the plume will also be analyzed for chloroform, 1,1-dichloroethane, and 1,1-dichloroethene in addition to those contaminants previously listed..

Comment No. 11:

On page 44, the proposed alternative calls for voluntary sealing of domestic wells by homeowners. It will be necessary to ensure that these wells are either properly sealed or that no cross connection between private and public supplies exists. Private systems should be properly disconnected from wells and flushed prior to being brought on-line with a public water system.

Response:

This paragraph has been revised to state that if the homeowner desires to be connected to the public water supply, it will be necessary to disconnect and/or abandon the well.

Comment No. 12:

Cement grout of concrete should not be used to seal planned abandoned wells. Both of these materials would drastically change the ground water pH in the immediate area, which would influence ground water sample quality. It is recommended that clean sand, clay, or gravel be placed in screened wells within the screened interval, followed by cement grout or neat cement. For open hole rock wells, it is recommended that holes be filled with clean sand, clay, or gravel to 10 feet below the casing, followed by a 1 to 2 foot bentonite seal before completing the hole with cement grout or neat cement.

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Response:

The backfilling of the abandoned wells will follow the suggested method.

Comment No. 13:

In the second paragraph, it should be noted that the GAC filter will be replaced approximately every 6 months.

Response:

The word "approximately" has been added.

Comment No. 14:

Since the second nitrate analyses for residential wells during the Phase I RI did not detect contaminant concentrations above health based levels, any discussion of nitrates or nitrate contamination in the FFS should be eliminated.

Response:

All discussions regarding nitrate contamination have been deleted.

Comment No. 15:

The discussions of the TCE plume and its apparent correlation to Potential Source Area No. 1 may still be premature. Please refer to our earlier comments, which appear in our July 20th Phase I Draft RI report comments.

Response:

The discussions of the TCE plume and apparent correlation to Potential Source Area No. 1 have been modified to include the area near the Sherwood Refinishing Shop (i.e., Potential Source Area No. 3b).

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SEPTEMBER 1988

FINAL

FOCUSED FEASIBILITY STUDY REPORT

CROYDON TCE SITE
BUCKS COUNTY, PENNSYLVANIA

EPA WORK ASSIGNMENT NUMBER 124-3LM7
UNDER
CONTRACT NUMBER 68-01-7250

PREPARED BY:
NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED BY:
EBASCO SERVICES INCORPORATED
LANGHORNE, PENNSYLVANIA

PREPARED BY:	APPROVED BY:
RAYMOND P WATTRAS	RICHARD C EVANS, P.E.
SITE MANAGER	REGIONAL MANAGER, REGION III
NUS CORPORATION	EBASCO SERVICES INCORPORATED

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Croydon TCE Site Focused Feasibility Study (FFS) Report was prepared to evaluate alternatives which prevent human exposure to contaminated groundwater having concentrations of trichloroethene (TCE) and related constituents in excess of Federal and state health-based standards (i.e., MCLs). A limited number of affected households (estimated to be 13) in the community of Croydon are without the service of a public water supply and are solely dependent on groundwater for everyday usage. These households are also located within an area where groundwater is contaminated with TCE at levels which exceed the Maximum Contaminant Level (MCL) of 5 µg/l.

Because the source of the contamination was unknown, a two-phased remedial investigation (RI) and feasibility study (FS) was proposed in August 1987. This Final FFS Report was prepared in conjunction with the Phase I RI to address the problem of groundwater exposure and the current threat to public health. Remedial alternatives which address source control or management of migration (for all contaminated media) will be developed for the Croydon TCE Site following the Phase II RI.

The Croydon TCE Site is located in the southernmost portion of Bristol Township, Bucks County, Pennsylvania. The site was identified by the United States Environmental Protection Agency (EPA) during the investigation of the Rohm & Haas Site, which borders part of the Croydon TCE Site (see Figure 1-1 in Section 1.0). Rohm & Haas Company, which operated an industrial landfill from 1952 to 1975, conducted an environmental study to determine whether the landfill presented a threat to human health or the environment. As part of this study, monitoring wells and residential wells north of the landfill area (i.e., upgradient with respect to groundwater flow) were found to be contaminated with TCE and other volatile compounds (primarily constituents of TCE). Rohm & Haas concluded that a plume of contaminated groundwater was emanating from a source upgradient from its landfill and has migrated onto Rohm & Haas' property. Because many of the businesses in the Croydon area may also use products containing TCE, EPA determined that a separate RI/FS was required to determine the source(s) of the plume migrating toward the Rohm & Haas Site. In September 1985, the Croydon TCE Site was included on the EPA National Priorities List (NPL) and ranked 616th.

The study area is bordered by Interstate 95 to the north, River Road and the Delaware River to the south, Neshaminy Creek to the west, and Route 413 to the east, and encompasses approximately 3.5 square miles. The study area is both residential and industrial in nature. In addition to the Rohm & Haas facilities, several small- to large-scale manufacturing facilities are located in Croydon. Approximately 2,500 people reside in Croydon and the surrounding areas. The manufacturing and commercial facilities are located in the eastern portion of Croydon, whereas the residential areas encompass the central, northern, and western portions of Croydon. Commercial businesses are primarily located along U.S. Route 13 and State Road, which run parallel to each other before they intersect with Route 413 (see Figure 1-1 in Section 1.0). The area north of U.S. Route 13 is mostly residential.

The "focused area of investigation" (see Figure 1-2 in Section 1.0), which is situated in the southeastern portion of the study area, includes a portion of the Croydon residential community and an area where several large- to small-scale manufacturing and commercial establishments are located. This area covers about 1 square mile. A limited number of homes within this area depend solely on groundwater for everyday usage. This FFS will be concerned with this "focused area of investigation" as opposed to the entire 3.5 square mile study area. Groundwater outside of the focused area of investigation is not contaminated with TCE, based on data collected during the Phase I RI.

The geology of the Croydon TCE Site consists of unconsolidated sand, gravel, silt, and clay deposits overlaying metamorphic bedrock. Total thickness of the unconsolidated deposits in well borings ranged from 29 to 69 feet in the study area and from 40 to 65 feet in the borings south of the study area (BCM, 1986). Bedrock underlying the unconsolidated deposits is described as Wissahickon Schist, a late Precambrian-early Paleozoic metamorphic rock unit of probable sedimentary origin, which is considered the basement rock in the area. The bedrock surface is irregular, and has an overall regional slope to the southeast.

The site is situated within the Delaware River Basin. The Delaware River forms a portion of the southern boundary of the study area and is the regional discharge point for both groundwater and surface water.

Two aquifer systems are present in the Delaware River Valley region. Groundwater occurs in both the unconsolidated deposits and in the underlying bedrock. The two flow systems are not interconnected in the study area because of the presence of local clay layers and a substantial thickness of weathered bedrock (saprolite) which inhibits the movement of groundwater between formations (BCM, 1986). In the vicinity of the site, the unconsolidated deposits are a source for domestic and industrial water supply. The bedrock groundwater flow system is of minor importance to groundwater supply in the vicinity of the site.

A Phase I hydrogeologic investigation was conducted to determine the nature and extent of groundwater contamination and assess public health risks posed by groundwater contaminants. The hydrogeologic investigation consisted of sampling 46 monitoring wells and 40 residential wells. Based on the Phase I analytical results, groundwater contamination is primarily limited to the southeastern portion of the study area (i.e., within the focused area of investigation). Contaminants of potential concern in the groundwater include chloroform (8.9 µg/l), 4,4-DDT (0.063 µg/l), 1,1-dichloroethene (75 µg/l), 1,1-dichloroethane (3 µg/l), dieldrin (0.30 µg/l), tetrachloroethene (4 µg/l), 1,1,1-trichloroethane (160 µg/l), and trichloroethene (420 µg/l). TCE and tetrachloroethene (PCE) are the only contaminants that exceeded health-based Applicable or Relevant and Appropriate Requirements (ARARs) in the residential well samples.

The TCE plume appears to be migrating from one or two potential source areas located just north of U.S. Route 13 (see Figure 1-2 in Section 1.0). The plume is migrating in a south-southeast direction in the direction of the regional groundwater flow. The highest concentrations of TCE and related compounds within the plume are observed in the area north of River Road and south of State Road. Generally, the deep monitoring wells installed in the unconsolidated deposits in this area had higher TCE concentrations than the shallow wells. The horizontal extent of the TCE plume is to the Delaware River, based on studies conducted by BCM for the Rohm & Haas Company. Monitoring wells located near the river have exhibited TCE levels as high as 100 µg/l. A baseline risk assessment was conducted using the data collected during the Phase I RI. Households located within the area of the TCE plume who use groundwater for everyday uses are at risk. Groundwater ingestion, inhalation of contaminants volatilized from groundwater household use, and dermal absorption and inhalation of contaminants while bathing were found to be above the EPA benchmark of a 10^{-6} carcinogenic risk.

Preliminary estimations have identified 13 homes within the TCE contaminated zone that are not serviced by the public water supply and depend on groundwater for everyday usage. Households that are located west or north of the TCE plume are not at risk since the plume is migrating in a south-southeast direction. Samples collected from residential wells located north and west of the groundwater contamination zone did not indicate the presence of TCE or other volatiles at elevated levels (less than 1 µg/l). No households are located east or south of the plume within the study area.

The number of homes without the services of a public water supply was estimated using information provided by the Borough of Bristol Water and Sewage Department. A listing of streets within the plume area was given to the Water and Sewage Department. Households along those streets that were not on the Department's water billing data base were identified and subsequently forwarded to the REM III Project Team.

The feasibility study process consisted of developing remedial action objectives and general response actions, identifying and screening technologies applicable to each general response action, assembling technologies into alternatives, and

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performing a detailed analysis on each of the candidate alternatives.

The development of remedial action objectives was focused on the protection of human health for those residents of Croydon who are solely dependent on groundwater for everyday use, and are located within the TCE-contaminated groundwater zone. The focused nature of this feasibility study did not address the remediation of groundwater throughout the study area since this will be addressed following the Phase II RI. Other medium-specific objectives (i.e., soil, surface water, etc.) and alternatives will also be addressed following the completion of the Phase II RI.

Due to the focused nature of this feasibility study, only two remedial action objectives were identified; prevent human exposure to contaminated groundwater, and reduce the contaminant level of TCE at the exposure point to acceptable levels (i.e., the MCL). A total of 3 remedial alternatives were subsequently identified and are described below.

No Action (Alternative No. 1) - This alternative was included for comparative purposes and provides a baseline assessment.

Alternate Water Supply With Monitoring (Alternative No. 2) - This alternative involves the construction of 13 new water service lines and the connection to the Borough of Bristol water supply mains. Only one street (Belleview Avenue) requires the construction of a 6-inch water main line. The other streets throughout the area of concern already have a water main line to connect into.

The intent of this alternative is to eliminate the present and future health risks associated with potable and nonpotable use of contaminated groundwater. Only those homes (13) that are at risk or may be at risk in the future were included in this alternative. A limited amount of groundwater monitoring was included to ensure that homes which are located outside of the groundwater contamination zone are not at risk by using the groundwater.

Individual Well Treatment with Granular Activated Carbon and with Monitoring (Alternative No. 3) - This alternative involves the installation of a granular activated carbon (GAC) treatment unit in each of the 13 homes using private wells in the area of concern. The intent of this alternative is to reduce the present and future health risks associated with the potable and nonpotable use of contaminated groundwater to acceptable levels. Monitoring of the GAC treated effluent would be required to ensure that the unit is operating properly. Additionally, the GAC unit will be serviced approximately every 6 months to replace the carbon. The vendor would have to be responsible for hauling the spent carbon away and disposing/treating it properly.

The detailed analysis of each alternative is summarized in Table ES-1. Remedial Alternative No. 2 (Alternate Water Supply) provides the best overall protection to the public health, is very reliable, and would most likely be acceptable to the State and community. Additionally, the present worth cost ($106,000) is lower than Alternative Number 3 ($312,000) since extensive monitoring and analysis is required for the later alternative. The present worth cost is based on a 30-year project life, a 5 percent discount rate, and zero inflation.

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TABLE ES-1

SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Short Term Effectiveness	Not Applicable	Public water systems are very reliable and require only minimal maintenance. Construction time is estimated to be 1 month.	Effectiveness is dependent on the specific chemicals present, their concentration, and the required degree of removal. GAC would be effective at the Croydon TCE Site, but monitoring of the effluent and TCE plume is required. Estimated construction time for installation of GAC units is 5 weeks.
Long Term Effectiveness and Permanence	Not Applicable	This alternative provides long-term reliability and any maintenance required would be the responsibility of the Borough of Bristol Water and Sewage Department. Maintenance of the water service lines on private property would be the responsibility of the homeowner, but this should be minimal.	For the contaminants detected at the site, GAC would be effective in reducing the concentration to acceptable levels. Future release of contaminants may increase in concentration or new contaminants may appear that cannot be effectively treated by GAC units (vinyl chloride). If contaminant concentrations increase significantly, the contamination may exhaust the carbon supply. Therefore, monitoring of both the groundwater and the treated effluent is required. For optimum operation, replacement of the carbon filter is necessary approximately every 6 months.

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TABLE ES-1
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE TWO

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility, or volume since no treatment or action is involved.	This alternative will eliminate exposure to contamination, but will not reduce the level of contamination in the groundwater. A forthcoming FS will address remediation of the groundwater plume and the source of contamination, if identified.	Reduction in toxicity at the exposure point is achieved. A forthcoming FS will address remediation of the groundwater plume and the source of contamination, if identified.
Implementability	Not Applicable	This alternative will need the approval of the Borough of Bristol Water and Sewage Department since EPA will transfer control once the operation begins. The Borough of Bristol Water and Sewage Department has adequate capacity to include the proposed number of new customers. Construction of the new water lines would not be difficult since existing lines are located throughout the area.	Availability of equipment and technicians to install and service the treatment units may present a problem since the vendor would be responsible for hauling the spent carbon away and disposing of it properly. Pilot testing would be required. Monitoring of the plume and GAC effluent would also be required. Right of Enter Agreements are necessary to install, service, and monitor the GAC units.
Compliance With ARARs	Does not meet ARARs	The Borough of Bristol water supply is regulated by the National Primary Drinking Water Regulations. Health-based ARARs (at the exposure point) will be satisfied. Groundwater contamination will remain, but this will be addressed in a forthcoming FS.	Health-based ARARs would be met (at the exposure point), but monitoring of the effluent is necessary to confirm that non-removable contaminants such as vinyl chloride do not appear in concentrations greater than the MCL (2 μg/l). Groundwater contamination will remain, but this will be addressed in a forthcoming FS.

TABLE ES-1
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE THREE

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Overall Protection of Human Health and the Environment	Public health risks will go unabated since no remedial action is undertaken. At present, there is a risk to groundwater users.	Implementation of this alternative would eliminate the health risks associated with groundwater exposure. This remedial alternative will not address protection of environmental receptors or risks resulting from exposure to media other than groundwater. A forthcoming PS will address these issues. Residents within the area who continue to use their groundwater for nonpotable purposes (i.e., watering the lawn) are not expected to incur any significant risk since exposure would be minimal. However, if residents wished to operate their private well in addition to having the services of a public water supply, the homeowner will be required to ensure that cross-contamination will not occur. Otherwise, the private wells will be sealed. A limited amount of groundwater monitoring will be necessary to ensure that homes located outside of the TCE contaminated zone without public water will not be at risk.	Health risks associated with exposure to contaminated groundwater would be reduced to acceptable levels, but would not eliminate all risks since future contaminants may increase in concentration or new contaminants may occur that cannot be effectively treated (i.e., vinyl chloride). Periodic replacement of the carbon filter is necessary or contaminant breakthrough could occur and exposure to contaminants would result in an unacceptable health risk. This remedial alternative will not address protection of environmental receptors or risks resulting from exposure to other media. A forthcoming PS will address these concerns.

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TABLE ES-1
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE FOUR

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Community and State Acceptance	It is very unlikely that the State or community would accept this alternative.	The state and community will most likely accept this alternative. Some homeowners may object to the fact that they will have to pay for the public water.	Questionable. EPA will seek transfer of control as soon as construction is complete. Local or state authorities will most likely not want to accept the expense of monitoring and servicing the GAC units. Community will fear that the O&M costs will be imposed upon them by the local authorities.
Cost(1)			
• Baseline Capital	-0-	$53,562	$64,496
• O&M (annual)(2)	-0-	$3,420	$29,900
• Baseline Present Worth(3)	-0-	$106,000	$312,000

(1) Sources include vendor estimates and Means - 1988 Site Work Data.
(2) Value represents years 1-5 only.
(3) Baseline present worth calculated for O&M period of 30 years.

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1.0 INTRODUCTION

NUS Corporation (NUS), under contract to Ebasco Services Incorporated (Ebasço), is pleased to submit this Final Focused Feasibility Study (FFS) Report to the U.S. Environmental Protection Agency (EPA). Preparation of this Final FFS was accomplished in response to Work Assignment Number 124-3LM7 under EPA Contract Number 68-01-7250. This FFS was developed in conjunction with the Phase I Remedial Investigation (RI) to evaluate alternatives which would prevent human exposure to contaminated groundwater via consumption, dermal contact, or inhalation of volatiles. Alternatives to eliminate these exposure routes are necessary since a number of residential dwellings within the study area are without the service of a public water supply and therefore, depend on groundwater for everyday usage. This FFS is necessary to address this problem since a threat to human health exists in certain areas of the study area. Remedial alternatives which address source control or management of migration (for all contaminated media) will be developed following the Phase II RI.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The Croydon TCE Site FFS Report was prepared to evaluate alternatives which prevent human exposure to contaminated groundwater having trichloroethene (TCE) and other contaminants in excess of Federal and state health-based standards (i.e., MCLs). A limited number of affected households (estimated to be 13) in the community of Croydon are without the service of a public water supply and are solely dependent on groundwater for everyday usage. These households are also located within an area where groundwater is contaminated with TCE at levels which exceed the Maximum Contaminant Level (MCL) of 5 µg/l. Residential well samples collected from households within this area exhibited levels of TCE as high as 97 µg/l. Monitoring well samples collected within this plume revealed levels of TCE as high as 420 µg/l.

The remainder of this section describes the site history, nature and extent of groundwater contamination, fate and transport of groundwater contaminants, and the baseline (no action) risk assessment. Section 2.0 identifies and screens technologies, based on the remedial action objectives and general response actions. The development and screening of alternatives is described in Section 3.0. Section 4.0 provides the detailed analysis and comparison of these alternatives.

1.2 SITE BACKGROUND

1.2.1 Site Description

The Croydon TCE Site is located in the southernmost portion of Bristol Township, Bucks County, Pennsylvania (see Figure 1-1). AR301462

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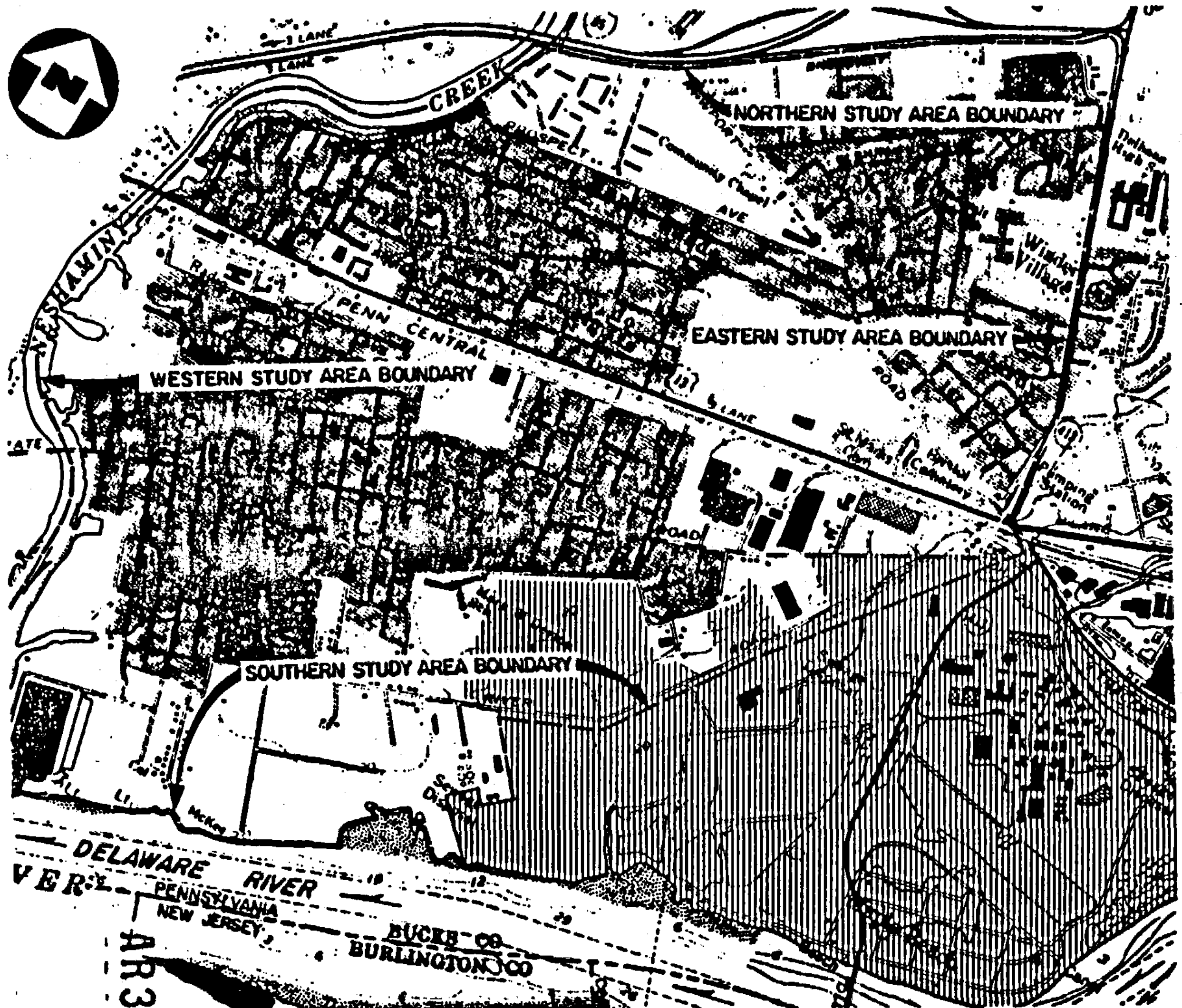

LEGEND

Study Area Boundary

Rohm and Haas Company Property

PENNSYLVANIA

QUADRANGLE LOCATION

BASE MAP IS AN ENLARGEMENT OF A PORTION OF THE U.S.G.S. BEVERLY, PA-NJ QUADRANGLE (7.5 MINUTE SERIES, 1966, PHOTOREVISED 1973, CONTOUR INTERVAL 20 FEET) AND A PORTION OF THE BRISTOL, PA-NJ QUADRANGLE (7.5 MINUTE SERIES, 1955, PHOTOREVISED 1981, CONTOUR INTERVAL 20 FEET)

0 1000 2000 3000 4000

SCALE IN FEET

FIGURE 1-1

LOCATION MAP
CROYDON TCE SITE, BUCKS COUNTY, PA

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Because the source of contamination was (and still is) unknown, and a possibility existed that widespread groundwater contamination was present in this area, a 3.5 square mile study area was established during the Phase I RI. As shown in Figure 1-1, the study area is bordered by Interstate 95 to the north, River Road and the Delaware River to the south, Neshaminy Creek to the west, and Route 413 to the east.

The area between River Road and U.S. Route 13, extending east of the Mary Devine Elementary School and west of Route 413, was studied extensively during the Phase I RI and has been referred to as the "focused area of investigation" (see Figure 1-2). The focused area of investigation, which lies within the "study area", and was studied extensively because (1) groundwater beneath this area was known to be contaminated with TCE, (2) some residential dwellings within this area are without the service of a public water supply and are using contaminated groundwater, (3) surface water in this area was known to be contaminated, (4) ten potential source areas within this area were identified through historical photographs, and (5) several small- to large-scale manufacturers who may have used products containing TCE are located in this area.

The focused area of investigation includes a portion of the Croydon residential community and an area where several large- to small-scale manufacturing and commercial establishments are located. This area covers about 1 square mile. A limited number of homes within this area depend solely on the use of groundwater for everyday usage. This FFS will be concerned with this "focused area of investigation" as opposed to the entire 3.5 square mile study area. Groundwater outside of the focused area of investigation is not contaminated with TCE, based on data collected during the Phase I RI.

The geology of the Croydon TCE Site consists of unconsolidated sand, gravel, silt, and clay deposits overlaying metamorphic bedrock. Unconsolidated deposits within the Delaware River Valley consists of Upper Cretaceous sediments of the Raritan Formation and Quaternary age deposits, primarily Pleistocene (Wisconsin) age glacial outwash in the form of valley fill deposits, which are overlain by a thin veneer of recent alluvium. Total thickness of the unconsolidated deposits in well borings ranged from 29 to 69 feet in the study area and from 40 to 65 feet in the borings south of the study area (BCM, 1986).

Bedrock underlying the unconsolidated deposits is described as Wissahickon Schist, a late Precambrian-early Paleozoic metamorphic rock unit of probable sedimentary origin, which is considered the basement rock in the area. The bedrock surface is irregular, and has an overall regional slope to the southeast.

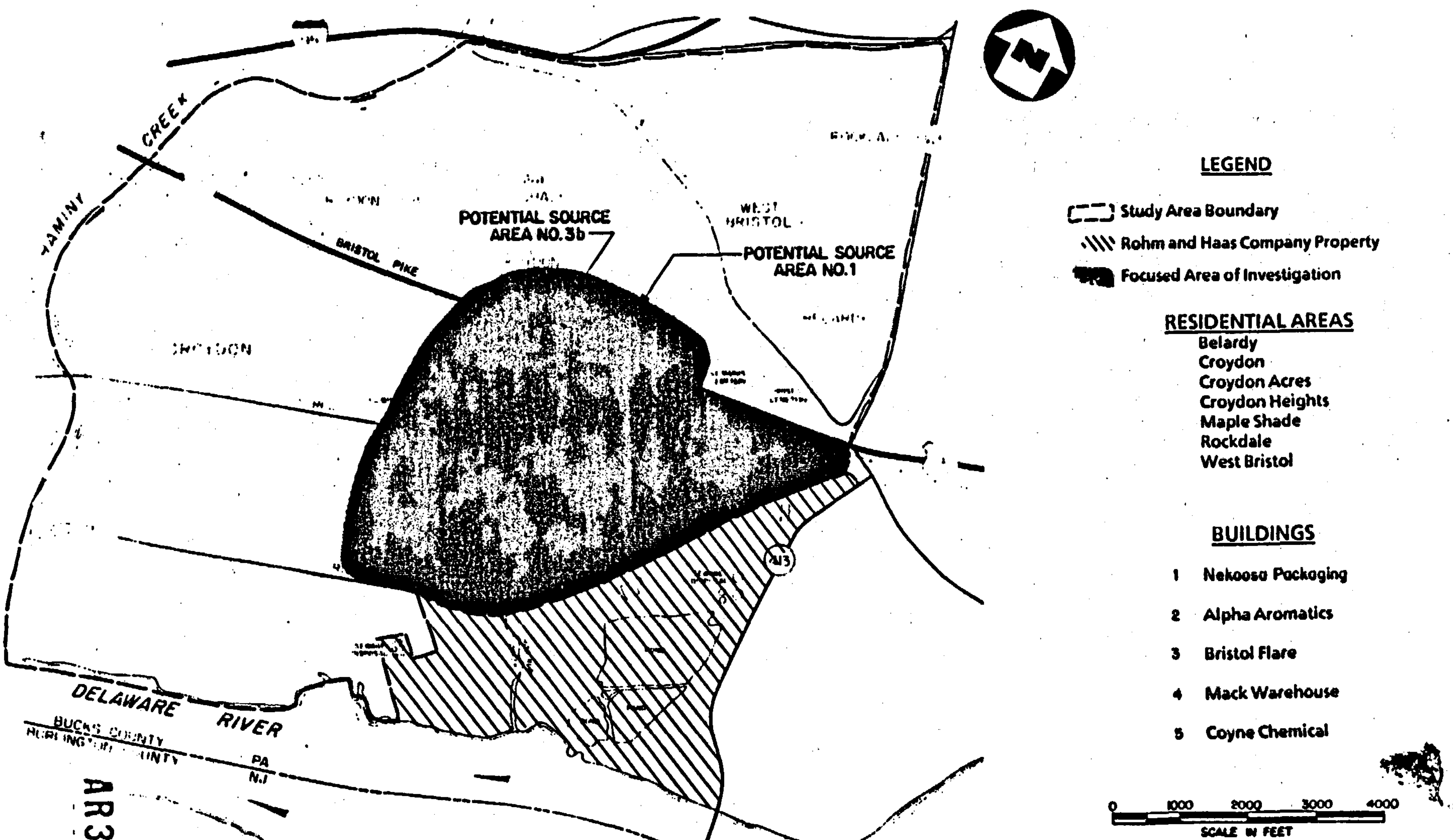

FIGURE 1-2

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GENERAL ARRANGEMENT
CROYDON TCE SITE, BUCKS COUNTY, PA

The site is situated within the Delaware River Basin. The Delaware River forms a portion of the southern boundary of the study area and is the regional discharge point for both groundwater and surface water.

Two aquifer systems are present in the Delaware River Valley region. Groundwater occurs in both the unconsolidated deposits and in the underlying bedrock. The two flow systems are not interconnected in the study area because of the presence of local clay layers and a substantial thickness of weathered bedrock (saprolite) which inhibits the movement of groundwater between formations (BCM, 1986). In the vicinity of the site, the unconsolidated deposits are a source for domestic and industrial water supply. Most of the domestic water supply is now received from the Borough of Bristol Water and Sewage Department, which is located east of the study area in Bristol, Pennsylvania. The bedrock groundwater flow system is of minor importance to groundwater supply in the vicinity of the site. There are currently no data describing any bedrock groundwater users in the local area, probably due to the ready availability of adequate groundwater supplies in the overlying unconsolidated deposits and the low hydraulic characteristics of the bedrock aquifer.

South of River Road (outside of the study area) is a large industrial landfill owned by Rohm & Haas Company (Rohm & Haas) and Chemical Leaman Tank Line, Inc. (BCM, 1988). At present, the landfill is being investigated by Rohm & Haas under a RCRA Corrective Action. The landfill was also studied by Rohm & Haas to determine whether it was the source of the TCE groundwater contamination that is present in the southeastern portion of the study area (north of River Road). However, based on studies conducted to date by Rohm & Haas, TCE-contaminated groundwater is migrating toward the landfill area (i.e., southward toward the Delaware River) and not toward the study area (i.e., northward toward River Road). Studies conducted by Rohm & Haas have indicated that the source of the TCE contamination is not likely to be migrating from the landfill. Therefore, this landfill was not included as part of the study area based on these studies. Data collected during the Croydon TCE Site Phase I RI support Rohm & Haas' findings and conclusions.

As shown in Figure 1-2, the Rohm & Haas Company property extends just north of River Road, but no landfilling or waste dumping by Rohm & Haas is known to exist in this area. This area of the company property is mainly undeveloped and does not contain any Rohm & Haas manufacturing facilities. It is being studied as part of this RI/FS since groundwater beneath it is contaminated with TCE and other organic constituents.

The Mary Devine Elementary School is located at the westernmost portion of the focused area of investigation (see Figure 1-2). Approximately 500 children in grades kindergarten through sixth grade attend this school. Rohm & Haas previously owned approximately 23 acres of land which included the school and surrounding grounds. However, it has been reported that no dumping was done in this area by Rohm & Haas (BCM, 1988). Several athletic fields, which are still owned by Rohm & Haas, are situated east of the elementary school.

For the most part, the remainder of the study area outside the focused area of investigation is primarily residential. With the exception of commercial establishments along State Road and U.S. Route 13, there are only a few small-scale, industrial manufacturing facilities outside the focused study area. Several residential communities, which were mainly constructed in the 1940s to 1960s, make up the western and northern portions of the study area. These communities include Croydon, Croydon Heights, Croydon Acres, Maple Shade, West Bristol, Belardy, and Rockdale. According to 1980 U.S. Census Bureau figures, approximately 67,500 people live in Bristol Township. Population figures were not available for the individual communities within the study area; however, it is estimated that the population within the study area could range from 2,000 to 3,000 people.

1.2.2 Site History

The Croydon TCE Site was identified by EPA after a series of events led to a remedial investigation of the Rohm & Haas Site, which forms part of the southern boundary of the Croydon TCE Site. The series of events began in 1978 when a congressional investigating subcommittee was formed to examine the potential threats posed by hazardous waste disposal sites across the country. The subcommittee requested waste disposal information from 53 of the largest chemical companies in the country. One of these companies, the Rohm & Haas Company, reported that hazardous waste produced by the company were disposed of on the company's property in Croydon, Bristol Township. Following a recommendation from the subcommittee, the EPA inspected the property and discovered that groundwater and surface water on the Rohm & Haas Site were contaminated by various organic compounds.

In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), better known as "Superfund." This act provided the state and Federal governments with the authority to address abandoned or uncontrolled hazardous waste disposal sites and established a fund for remediating the sites once they were identified. As required by the new law, Rohm & Haas notified the EPA that the wastes disposed on its Bristol Township property included 43 tons of RCRA-hazardous waste by definition, or had components listed as hazardous (BCM, 1988). Total process waste in the landfill is estimated to be 268,000 tons (BCM, 1988).

Subsequently, in 1983, Rohm & Haas hired BCM Eastern Incorporated (BCM) to conduct studies on its Bristol Township property. Following this investigation, BCM released two reports: <u>Report on Landfill Investigation, April 1984</u>, and

Landfill Investigation, February 1985. The reports concluded that the property posed no threat to human or environmental health. Nevertheless, the EPA proposed the Rohm & Haas Site for the National Priorities List (NPL) in April 1985 and thereby identified the site for long-term remedial action under the Superfund Act.

Under the REM III Program, BCM's reports were reviewed by Ebasco, Incorporated (Ebasco), for EPA. Ebasco submitted a report to EPA in November 1985 that identified some deficiencies in the BCM reports. However, Ebasco concurred with BCM's conclusions, which suggested that a plume of contaminated groundwater appeared to emanate from an apparent source (or sources) and is migrating onto the Rohm & Haas property. Because the source of the contaminated plume was not identified and because many of the businesses in the Croydon area may also use products containing TCE, the EPA determined that a separate RI/FS was required to characterize the nature and extent of the contamination, assess the public and environmental health risks associated with the contamination, and identify potential remedial alternatives.

In April 1985, the NUS Corporation Field Investigation Team (FIT) prepared a Hazard Ranking Score (HRS) for the Croydon TCE Site. An HRS of 31.60 was calculated. This score was based on the findings of the Rohm & Haas investigations, which included data for groundwater, surface water (Hog Run Creek), and sediments in the southeastern portion of the Croydon TCE study area. Because the source of contamination was unknown, a site boundary could not be established. In September 1985, the Croydon TCE Site was selected for inclusion on the National Priorities List (NPL) and ranked 616th.

Because only a limited amount of information was available for the study area and the source(s) of the TCE groundwater contamination was unknown, a two-phased RI/FS was proposed to gather sufficient information to meet the project goals. The scoping of the Phase I RI/FS was conducted by the REM III Team during a 3-week period following the site reconnaissance of March 24, 1987. The Final Phase I RI/FS Work Plan was submitted to EPA in August 1987. The Phase I RI/FS objectives are outlined below.

- Characterize the nature and extent of groundwater contamination detected within the southeastern portion of the study area (i.e., the focused area of investigation).
- Assess the public health and environmental risks posed by groundwater within the study area.
- Determine the quality of local surface water to estimate the impact from groundwater discharge and estimate health and environmental risks associated with the use of these waters.

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- Identify potential source areas that may be contributing to the groundwater contamination which is present within the southeastern portion of the study area.

- Determine the presence or absence of contaminants in soil where suspected landfill material may have been disposed.

Various field investigations were conducted to acquire the appropriate data to meet the Phase I objectives. These studies included a hydrogeologic investigation, a residential well survey/investigation, and a surface water and sediment investigation. A limited amount of soil sampling was also undertaken in response to an EPA request. The request was made following a public meeting when a local resident indicated that fill material from the Rohm & Haas Landfill was allegedly disposed throughout Croydon. Three separate areas were identified by the local resident and subsequently sampled.

The field activities were conducted during the period September 1987 - March 1988. The data was subsequently analyzed and evaluated, and a Final Phase I RI Report was submitted to EPA in August 1988. The findings and conclusions of the Phase I study, along with the baseline risk assessment, are summarized in the following subsections.

1.2.3 Summary of the Phase I Remedial Investigation Findings

A summary of the nature and extent of contamination identified in groundwater, surface water, sediment, and soil within the Croydon TCE Site study area is provided below.

- A plume of contaminated groundwater was identified in the southeastern portion of the study area. The plume appears to originate from one or two potential source areas just north of U.S. Route 13 (see Figure 1-2) and is migrating in a south-southeast direction. Trichloroethene and related compounds are the predominant contaminants detected in this plume.

- The occurrence and distribution of groundwater contamination suggests the possible presence of a second TCE plume originating from an offsite area east of Route 413. Localized groundwater flow is toward the northeast, opposite of the regional flow system in this area.

- Lead was detected above health-based standards in 1 out of 40 residential well samples. This contaminant is not related to the groundwater contamination which is associated with this site. The presence of lead may be due to the household plumbing or well system, where lead piping or solder may be present.

- Surface water and sediments in Hog Run Creek and the pond behind the VFW Post contain low levels (less than

10 µg/l) of volatile organic compounds. Groundwater discharge to this surface water is considered the source of these compounds.

- Sediments within the study area contain polycyclic aromatic hydrocarbons (PAHs) and slightly elevated levels of several inorganic constituents. Based on the findings and conclusions of the Phase I RI, these constituents are probably unrelated to contamination associated with the site.

- Surface soil samples were obtained from three areas where fill material from the Rohm & Haas landfill was allegedly placed. The samples contained PCBs, PAHs, and/or pesticides. Based on the Phase I RI data, it is unknown whether these compounds are associated with the Rohm & Haas landfill, represent background levels, or are attributable to another contaminant source. This will be investigated during the Phase II RI.

As mentioned previously, an FS that addresses all environmental media will be conducted in conjunction with the Phase II RI. The Phase II RI will focus on the following:

- Investigate the area north of U.S. Route 13 (Potential Source Area No. 1 and No. 3b) to determine whether this area may be the source of the groundwater contamination.

- Delineate the northern boundary of the TCE plume.

- Determine whether another "offsite" plume of TCE is migrating onto the Croydon TCE Site near River Road and Route 413.

- Verify public health risks posed by the use of groundwater within the study area.

- Verify the presence or absence of PCBs in the soil.

Because the FFS addresses only groundwater exposure, the following subsection only provides additional information on the nature and extent of groundwater contamination.

1.2.4 <u>Nature and Extent of Groundwater Contamination</u>

Twenty-nine REM III monitoring wells, seventeen existing Rohm & Haas monitoring wells, and forty residential wells were sampled during the Phase I RI. Residential-well and monitoring-well sampling locations are shown on Figure 1-3. Figure 1-3 also provides the level of TCE for each one of these sampling locations so that the plume can be depicted.

Figure 1-3 - See back pocket.

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The primary objectives of the monitoring-well sampling were to characterize the nature and extent of groundwater contamination in the southeastern portion of the study area and to identify potential source areas that may be contributing to groundwater contamination. Residential wells were sampled to characterize water quality throughout the Croydon TCE Site study area (i.e., the 3.5 square mile area) and to assess the potential public health risks associated with groundwater use.

All new and existing monitoring wells and all residential wells were analyzed for Target Compound List (TCL) volatile organics. Ten residential wells (RW30 through RW39) were analyzed for selected water chemistry parameters in addition to the TCL volatiles. Additionally, selected monitoring wells (LF-13-18, LF-13-43, LF-15-26, LF-15-37, MW3(S), MW3(D), MW5(S), MW5(D), MW13(S), and MW13(D) and selected residential wells (RW1 through RW8) were analyzed for TCL base-neutral acid (B/N/A) extractable organics, TCL pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) inorganics, and cyanide.

Organic and inorganic compounds detected in monitoring wells and residential wells are given on Tables 1-1 and 1-2, respectively.

Based on the Phase I chemical analytical results, groundwater contamination is primarily limited to the southeastern portion of the study area (i.e., focused area of contamination). Contaminants of potential concern in the groundwater are given on Table 1-3. Of these contaminants, TCE and PCE were detected at concentrations above health-based ARARs.

As shown on Figure 1-3, the TCE plume appears to be migrating from the area north of U.S. Route 13. The plume is migrating in a south-southeast direction in the direction of the regional groundwater flow. The highest concentrations of TCE and related compounds within the plume are observed in the area between River Road and State Road. Monitoring wells MW8(D), MW5(D), MW15(S), MW15(D), CR26(D), and LF-13-43 exhibited the highest concentrations of TCE. Generally, the deep monitoring wells installed in the unconsolidated deposits in this area had higher TCE concentrations than the shallow wells. The horizontal extent of the TCE plume has reached the Delaware River, based on studies conducted by BCM for the Rohm & Haas Company. Monitoring wells sampled by BCM, which are located near the river have exhibited TCE levels as high as 100 µg/l.

Groundwater contamination associated with the plume would primarily discharge to the East Branch of Hog Run Creek. However, on the south side of the East Branch of Hog Run Creek, local groundwater flow is toward the northwest, in the opposite direction of regional flow. The TCE contamination detected in monitoring wells MW15S and MW15D may to be associated with another source. Historical data suggest this contamination may be the result of the presence of another "offsite" plume originating east of Route 413 (BCM, 1988). This offsite plume

TABLE 1-1

ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN MONITORING WELLS CROYDON TCE SITE

Compound	Maximum(1) Detected Concentration	Location (Maximum Concentration)
Acetone	9.5J	CR-18-55
2-Butanone	3.0J	CR-23-32
Benzene	0.4J	MW1(D)
1,1,1-Trichloroethane	160	MW15(S)
1,1,2-Trichloroethane	0.7J	MW15(D)
1,1-Dichloroethane	3J	MW15(D)
1,2-Dichloroethane	16J	MW8(D)
Cis-1,2-dichloroethene	1.4	CR-19-37
Tetrachloroethene	4.1J	MW5(D)
Trichloroethene	420	MW15(D)
Trans-1,2-Dichloroethene	4.6	CR-18-55
1,1-Dichloroethene	75	MW15(D)
Chloroform	8.9	LF-13-18
Chlorodibromomethane	0.3	LF-15-26
Bromodichloromethane	0.4J	MW5(S)
Cis-1,2-dichloroethane	0.1J	MW15(S)
Bis(2-ethylhexyl)phthalate	4J	LF-15-37
4,4-DDT	0.3J	MW5(S)
Dieldrin	0.3	LF-15-26
Aluminum(2)	129,000/ND(2)	MW5(S)
Antimony	25/ND	MW5(S)
Arsenic	31/ND	MW13(S)
Barium	4,800/36	MW13(S)

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TABLE 1-1
ORGANIC AND INORGANIC CONSTITUENTS DETECTED
IN MONITORING WELLS
CROYDON TCE SITE
PAGE TWO

Compound	Maximum(1) Detected Concentration	Location (Maximum Concentration)
Cadmium	5.2/ND	MW13(D)
Calcium	31,000/14,000	MW13(S)
Cobalt	744/13	MW13(S)
Copper	1,780/26	MW13(S)
Chromium	2,000/ND	MW13(S)
Iron	257,000/363J	MW5(S)
Lead	68/[4.4]	MW5(S)
Magnesium	167,000/8,420	MW13(S)
Manganese	11,300/4,100	MW5(S)
Mercury	1.1/ND	MW13(S)
Nickel	1,690/ND	MW13(S)
Potassium	51,500/2,750	MW13(S)
Sodium	17,700/15,600	MW5(S)
Zinc	5,350/29	MW13(S)
Ammonia (as N) (mg/l)	0.34	MW5(S)
Chloride (mg/l)	63.4	MW5(S)
Nitrite/Nitrate (mg/l)	0.138/2.12	MW13(S)

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TABLE 1-1
ORGANIC AND INORGANIC CONSTITUENTS DETECTED
IN MONITORING WELLS
CROYDON TCE SITE
PAGE THREE

Compound	Maximum(1) Detected Concentration	Location (Maximum Concentration)
Sulfate (mg/l)	78.3	MW5(D)
TDS (mg/l)	1,300	MW13(S)
TOC (mg/l)	1.0	LF-13-18
TSS (mg/l)	33,010	MW13(S)
BOD (mg/l)	122	MW13(S)
Alkalinity ($CaCO_3$) (mg/l)	43.2	MW13(S)

(1) Results reported in µg/l unless otherwise noted.
(2) Metal analyses reported as total metals/dissolved metals.
J: Denotes reported value is estimated. Actual value may be higher or lower.
ND: Not detected above instrument detection level.
[]: Brackets denotes that the reported value was below the method detection level.

TABLE 1-2

ORGANIC AND INORGANIC CONSTITUENTS
DETECTED IN RESIDENTIAL WELLS
CROYDON TCE SITE

Compound	Maximum(1) Detected Concentration	Location (Maximum Concentration)
Benzene	3.8	RW32
Ethylbenzene	16	RW32
Chlorobenzene	0.02	RW32
1,1,1-Trichloroethane	75	RW34
1,1,2-Trichloroethane	0.05	RW34
1,1-Dichloroethane	3	RW33
1,2-Dichloroethane	3.3	RW18
Tetrachloroethene	4.3	RW34
Trichloroethene	97	RW21
Trans-1,2-dichloroethene	0.06	RW33
1,1-Dichloroethene	5.1J	RW34
Vinyl chloride	.19J	RW33
Carbon tetrachloride	0.24	RW35
Chloroform	1.2	RW1
Methylene chloride	100J	RW6
Bromodichloromethane	0.02	RW31
Butyl benzyl phthalate	8.2J	RW1
1,2-Dichlorobenzene	0.10	RW33
1,3-Dichlorobenzene	0.22	RW33
1,4-Dichlorobenzene	0.20	RW26
Aluminum	1,850J(2)	RW1
Barium	[106]L	RW4
Cadmium	[2,610]	RW7
Calcium	17,800	RW8
Copper	399	RW1
Iron	9,100J	RW1

TABLE 1-2
ORGANIC AND INORGANIC CONSTITUENTS DETECTED
IN RESIDENTIAL WELLS
CROYDON TCE SITE
PAGE TWO

Compound	Maximum(1) Detected Concentration	Location (Maximum Concentration)
Lead	104K	RW1
Magnesium	11,000	RW4
Manganese	184	RW4
Mercury	0.2	RW1 RW7 RW2
Nickel	[16]	RW1
Potassium	[3,880]	RW2
Sodium	26,300	RW4
Vanadium	12	RW3
Zinc	385J	RW2
Ammonia (as N) (mg/l)	0.3	RW33
Chloride (mg/l)	49	RW38
Nitrite/Nitrate (as N) (mg/l)	0.26	RW35
Sulfate (mg/l)	86	RW39
TDS (mg/l)	320	RW35
TSS (mg/l)	415	RW32
BOD (mg/l)	14	RW32
Alkalinity ($CaCO_3$) (mg/l)	71	RW30

(1) Results reported in µg/l unless otherwise noted.
(2) Metal analyses for samples which are unfiltered: total metals
ND: Not detected above instrument detection level.
J: Denotes reported value is estimated. Actual value may be higher or lower.
L: Denotes reported value may be biased low. Actual value may be higher.
K: Denotes reported value may be biased high. Actual value may be lower.
[]: Brackets denote that the reported value is below the method detection level.

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TABLE 1-3

CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER AT THE CROYDON TCE SITE

Contaminants of Concern in Monitoring Wells	Maximum Detected Concentration (µg/l)	Health-Based ARARs (µg/l)		
		MCLG(a)	MCL(b)	Other(c)
Chloroform	8.9	--	100(d)	NA
4,4'-DDT	0.3J	--	--	$(1.2x10^{-3})$
1,1-Dichloroethane	3.0J	--	--	NA
1,1-Dichloroethene	75	--	7	NA
Dieldrin	0.3	--	--	$(1.1x10^{-3})$
Tetrachloroethene	4.1J	0(e)	--	NA
1,1,1-Trichloroethane	160	200	200	NA
Trichloroethene	420	0	5	NA

Contaminants of Concern in Residential Wells	Maximum Detected Concentration (µg/l)	Health-Based ARARs (µg/l)		
		MCLG(a)	MCL(b)	Other(c)
Chloroform	1.2	--	100(d)	NA
1,1-Dichloroethane	3	--	--	NA
1,1-Dichloroethene	5.1J	--	7	NA
Tetrachloroethene	4.3	0(e)	--	NA
1,1,1-Trichloroethane	75	200	200	NA
Trichloroethene	97	0	5	NA

(a) Maximum Contaminant Level Goal. MCLGs are nonenforceable goals which are set at levels which would result in no known or anticipated adverse health effects with an adequate margin of safety.

(b) Maximum Contaminant Level. MCLs are enforceable standards that are set as close to MCLGs as is feasible after consideration of treatment technologies, costs, availability of analytical methods, and other factors.

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TABLE 1-3
CONTAMINANTS OF POTENTIAL CONCERN IN MONITORING WELLS AND RESIDENTIAL WELLS AT THE CROYDON TCE SITE
PAGE TWO

(c)	Ambient Water Quality Criteria, adjusted for drinking water only, are used as ARARs for those chemicals for which no MCL or MCLG exists. Value in parenthesis is the ambient water concentration risk assuming a person drinks 2 liters of water/day and weighs 70 kg.
(d)	Standard is for total trihalomethanes.
(e)	Proposed.
--	This criterion has not been developed for this chemical.
NA	Not Applicable; other criteria, such as adjusted AWQC, are used as ARARs only for those chemicals for which neither MCLs or MCLGs are available.

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appears to be migrating onto the Croydon TCE Site and combining with the Croydon TCE plume near River Road. This possibility will be investigated during the Phase II RI.

1.2.5 Baseline Risk Assessment - Human Exposure to Groundwater

A baseline risk assessment was conducted using the data collected during the Phase I RI. This risk assessment was performed using the guidelines established in the Superfund Health Evaluation Manual (EPA, 1986).

Household occupants located within the area of the TCE plume who use groundwater for everyday uses are at risk. The risks associated with groundwater ingestion, inhalation of contaminants volatilized from groundwater household use, and dermal absorption and inhalation of contaminants while bathing were found to be above the EPA benchmark of a 10^{-6} carcinogenic risk. The average and plausible maximum risk levels are outlined on Table 1-4 for these exposure pathways. Future use of the groundwater was also evaluated. These risk calculations are based on data collected from monitoring wells within the TCE contaminated zone, as shown on Figure 1-3.

Households that are located west or north of the TCE plume are not at risk since the plume is migrating in a south-southeast direction. Samples collected from residential wells along Linton, Emily, Keystone, and Summit avenues did not indicate the presence of TCE or other volatiles at elevated levels (<1 µg/l). These streets are located west of the plume (see Figure 1-3). Additionally, no contamination was found in households located along High Street, Maple Avenue, or Garfield Avenue. These streets are located north of the plume. No households are located east or south of the plume within the study area.

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TABLE 1-4

SUMMARY OF RISK ASSESSMENT SCENARIOS FOR HUMAN EXPOSURE TO GROUNDWATER CONTAMINANTS AT THE CROYDON TCE SITE

Exposure Pathways	Current Total Excess Upperbound Lifetime Cancer Risk*		Current Hazard Index for Noncarcinogenic Risks*	
	Average Case	Plausible Maximum Case	Average Case	Plausible Maximum Case
Ingestion of Groundwater	2×10^{-6}	1×10^{-4}	<1	<1
Inhalation of Volatile Organic Chemicals Released Indoors from Contaminated Groundwater	4×10^{-6}	2×10^{-4}	<1	<1
Dermal Absorption While Bathing in Contaminated Groundwater	5×10^{-6}	4×10^{-4}	<1	<1

* Risks are based on data collected from residential wells and represent current conditions.

Exposure Pathways	Future Total Excess Upperbound Lifetime Cancer Risk**		Future Hazard Index for Noncarcinogenic Risks**	
	Average Case	Plausible Maximum Case	Average Case	Plausible Maximum Case
Ingestion of Groundwater	7×10^{-5}	2×10^{-3}	<1	<1
Inhalation of Volatile Organic Chemicals Released Indoors from Contaminated Groundwater	7×10^{-6}	3×10^{-3}	<1	<1
Dermal Absorption While Bathing in Contaminated Groundwater	7×10^{-6}	3×10^{-3}	<1	<1

** Risks are based on data collected from monitoring wells and represent future conditions.

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2.0 DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES

The FS process involves the development of alternatives, the screening of alternatives, and the detailed analysis of alternatives for the remediation of a site. Alternatives for remediation are developed by assembling technologies into alternatives that address contamination on a sitewide basis or for an identified operable unit. For this FFS, alternatives for eliminating or reducing the risks posed by groundwater usage and exposure will be developed. The FS process involves six steps as outlined below.

1. Develop remedial action objectives specifying the contaminants and media of interest, exposure pathways, and remediation goals that permit a range of treatment and containment alternatives to be developed. The objectives developed are based on contaminant-specific ARARs, when available, and risk-related factors. For this FFS, remedial action objectives are focused on exposure pathways/risks for those residents who depend on groundwater for everyday use.

2. Develop general response actions for each medium of interest defining containment, treatment, excavation, pumping, or other actions, singly or in combination, that may be taken to satisfy the remedial action objectives for the site. Because of the focused nature of this FFS, the only media considered is groundwater.

3. Identify volumes or areas of media to which general response actions might be applied, taking into account the requirements for protectiveness as identified in the remedial action objectives and the chemical and physical characterization of the site. This FFS is limited to a portion of the focused area of investigation where a current health risk exists for those residences without the service of a public water supply.

4. Identify and screen the technologies applicable to each general response action to eliminate those that cannot be implemented technically at the site. The general response actions are further defined to specify remedial technology types.

5. Identify and evaluate technology process options to select a representative process for each technology type retained for consideration.

6. Assemble the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate.

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This section of the FFS addresses the following:

- Identification of remedial action objectives and general response actions (Steps 1 through 3).
- Identification of remedial technologies based on the remedial action objectives and general response actions (Step 4).
- Screening of technologies for technical suitability (Steps 4 and 5).
- Sections 3.0 and 4.0 identify and evaluate the remedial alternatives respectively (Step 6).

2.1 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The development of remedial action objectives has been focused on the protection of human health for those residents of Croydon who are solely dependent on groundwater for everyday use, and are located within the TCE-contaminated groundwater zone (see Figure 1-3). The focused nature of this feasibility study does not address the remediation of groundwater throughout the study area since this will be addressed following the Phase II RI. Other medium-specific objectives (i.e., soil, surface water, etc.) and alternatives will also be addressed following the completion of the Phase II RI.

Table 2-1 identifies the remedial action objectives for this FFS. General response actions that satisfy these objectives are also included in this table. Exposure pathways associated with groundwater include ingestion, inhalation, and dermal contact. Together, all three of these pathways present a health threat in excess of the carcinogenic risk of 10^{-4} for average future use and 10^{-5} for the current average case.

Two objectives have been identified. The first objective focuses on a total prevention of human exposure to the groundwater. The second objective focuses on the reduction of groundwater contaminants at the point of exposure to acceptable levels. The general response actions are limited in number since this FS is focused on residences that are not serviced by a public water supply and are located within an area that is known to have contaminated groundwater. "No action" has been included as a general response action for comparative purposes. In summary, the general response actions are:

- Alternative water supply
- Individual well treatment
- No action

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TABLE 2-1

REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS
CROYDON TCE SITE

Remedial Action Objectives	General Response Actions
1. Prevent human exposure to contaminated groundwater.	• No action • Alternate water supply
2. Reduce the contaminant level of TCE in groundwater to acceptable levels (i.e., MCL)	• No action • Individual well treatment

2.2 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Potential remedial technologies for each of the response actions are listed in Table 2-2. These technologies were identified based on a listing of technologies provided in the <u>Guidance Document for Providing Alternate Water Supplies</u> (USEPA 1987).

Treatment technologies that are not applicable for home installation have not been included in the initial list of technologies. These technologies are not considered feasible at this time but will be evaluated following the Phase II RI.

The initial list of remedial technologies contained in Table 2-2 was prescreened for technical suitability. The prescreening criteria included the following:

- Implementability - constructability and time to achieve cleanup.

- Applicability - physical and chemical suitability for site condition.

2.2.1 <u>Connection to an Existing Water Supply</u>

The construction of new water lines, and connection to the existing public water system is a feasible technology that is based on common engineering and construction practices. The Borough of Bristol Water and Sewage Department is a public (municipally owned) water supplier serving the Bristol and Croydon area. The existing water distribution system serving the Croydon area is shown on Figure 2-1. The Bristol Borough Engineer (Middle Atlantic States Engineering, Inc.) indicated the existing capacity of the treatment plant is 9 million gallons per day (mgd) and the capacity of the distribution system is 8 mgd with an additional capacity of 1.5 mgd for peak flows (Wright, 1988). The water demand promised to date is approximately 7.1 mgd, based on average flow; thus, the existing water system has adequate capacity to provide new service to the residents of Croydon who are currently using private wells for their water supply (approximately 13 homes). This technology is retained for further evaluation; however, a limited amount of groundwater monitoring is necessary to ensure that homes outside of the TCE contaminated zone without public water are not at risk.

2.2.2 <u>Development of New Water Sources</u>

New water sources may include shallow wells that are drilled upgradient of the contaminated source or deeper wells that are drilled into the aquifer located below the contaminated aquifer and not hydraulically connected to it. At the Croydon TCE Site, a deeper aquifer is located below the contaminated aquifer, but the capacity of this aquifer is not sufficient to provide adequate supply for the residents who are using groundwater wells. The use of shallow wells upgradient of the contamination

TABLE 2-2

GENERAL RESPONSE ACTIONS AND
ASSOCIATED REMEDIAL TECHNOLOGIES
CROYDON TCE SITE

General Response Actions	Remedial Technologies
No action	----
Alternate water supply	• Connection with existing water supply • Develop new water resources • Install oversized community storage
Individual well treatment	• Carbon adsorption units

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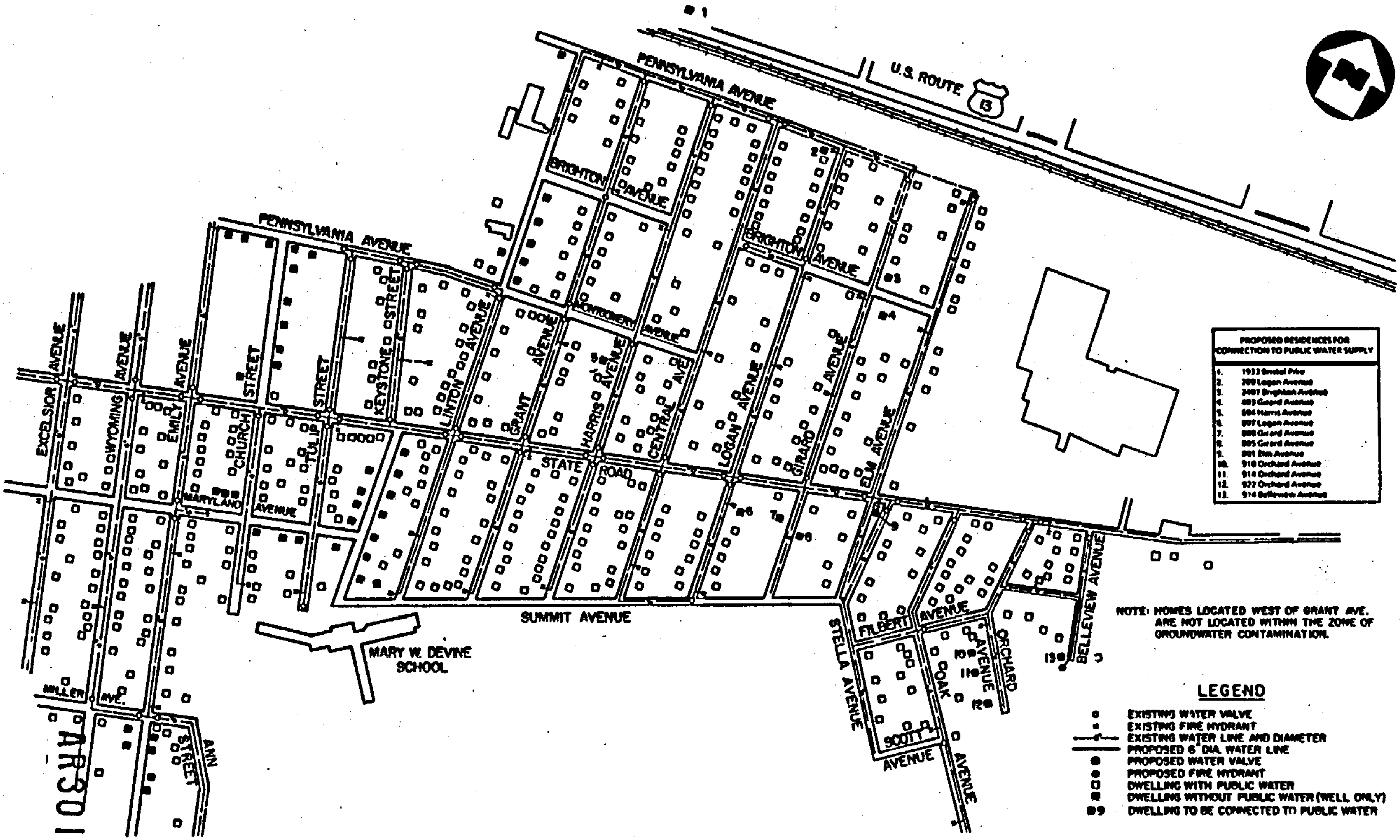

FIGURE 2-1

0 400 800
SCALE IN FEET

NUS CORPORATION

PUBLIC WATER SUPPLY SYSTEM SERVING THE CROYDON AREA
CROYDON TCE SITE, BUCKS COUNTY, PA

source is not applicable to the Croydon TCE Site since the contamination source is not clearly defined at this time and such a system would require an extensive water distribution system.

New water sources may include streams, rivers, ponds, lakes, and reservoirs. These new surface water sources would also require an extensive water distribution and treatment system which is not practical since the existing public water system has adequate capacity and has a distribution system that serves the major portion of the Croydon area (see Figure 2-1).

Also, since the location of the source is unknown, it may be difficult to site the location of potential water supplies and detailed sampling and analysis would be required. Thus, the development of a new water source is not retained for further evaluation.

2.2.3 Oversized Community Storage Facilities

If an alternate water supply does not have sufficient yield to meet maximum demand, round-the-clock pumping and an oversized storage facility may provide adequate flows. Such facilities are commonly used only for demand fluctuations, fire flows, emergencies, or other situations in which the demand exceeds normal daily demand. Since the Bristol Borough Water Authority has a capacity of 8 million gallons per day (mgd), a promised demand of 7.1 mgd, and an additional capacity of 1.5 mgd for peak flows, a new oversized storage facility is not required for the Croydon TCE Site and this technology is not retained for further evaluation.

2.2.4 Carbon Adsorption

Depending on the contaminants present, a treatment process can be designed to remove contaminants and reduce levels to comply with drinking water standards. The treatment necessary to remove a variety of contaminants can be complex and can involve treatment trains consisting of various processes in series. Processes used can be physical, chemical, or a combination of these. However, in this case, the only practical treatment technology that is applicable for home installation is granular activated carbon (GAC). Whereas GAC can generally remove a broad range of organics from drinking water, its effectiveness depends on the specific chemicals present, their concentrations, and the required degree of removal. As with any treatment system, GAC design and economics should be developed on the basis of adequate characterization of the influent and pilot testing. The system described below is subject to modification, based on development of more data.

A 10 gallon carbon capacity pressure unit is proposed to provide the necessary contact time and the anticipated carbon use rate (see Appendix A for calculations). The unit would be fed by the well pump and would feature an automatic-timer-operated back wash cycle to remove solids that accumulate. Backwashing frequency depends on the quality of well water, which cannot be projected for each of the individual wells because of differences in well depth and construction. Since the carbon bed will capture suspended particulates that may be present in groundwater supplies, backwashing is required to avoid excessive pressure loss, which will interfere with the operation. The backwash would be discharged to the sewer (this effluent would not contain TCE--but rather suspended solids).

Replacement of the carbon is anticipated approximately every 6 months by the vendor. In order to provide proper operation and maintenance of the units, contractor service is required. Provisions would have to be made between EPA and the vendor for the disposal of the spent carbon since it would be contaminated with TCE and other contaminants. Quarterly testing of the effluent is also necessary to verify that the system is operating properly. Since contaminant concentrations may increase and new contaminants may occur that cannot be effectively treated by the GAC treatment, it is also necessary to monitor the groundwater for significant changes in quality.

The treatment of groundwater from private wells using individual GAC units will be retained for further consideration since it is the only individual water treatment technology applicable for home installation.

2.2.5 Technology Prescreening Summary

The technologies that passed the prescreening are as follows:

- Connection to an existing water supply
- Individual well treatment with granular activated carbon

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3.0 REMEDIAL ALTERNATIVES DEVELOPMENT AND SCREENING

The remedial technologies which passed the screening step were used to develop remedial alternatives. Because of the focused nature of the feasibility study, the remedial technologies themselves are sufficient to meet the focused site objectives and can serve as individual alternatives. A total of three remedial alternatives have been identified:

- No. 1 - No Action
- No. 2 - Connection to Public Water System with Monitoring
- No. 3 - Individual Well Treatment with GAC and with Monitoring

Remedial alternatives are normally screened for effectiveness, implementation, and cost prior to performing a detailed evaluation. However, since only three alternatives remain, the remedial alternative screening has been eliminated and the detailed evaluation on each of the above remedial alternatives will be performed.

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4.0 REMEDIAL ALTERNATIVES DESCRIPTION AND EVALUATION

The three remedial alternatives developed in Section 3.0 are evaluated in detail and costed in this section.

The evaluation criteria used are:

- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Implementability
- Compliance with ARARs
- Overall protection of human health and the environment
- Community acceptance
- State acceptance
- Cost

Factors for each evaluation criteria are summarized in Table 4-1. Cost estimates for the alternatives considered are described in Section 4.4.

4.1 REMEDIAL ALTERNATIVE 1 - NO ACTION

This alternative will not require implementation of remedial actions, and the present and future potential human health and environmental risks will continue unabated. These risks have been identified and discussed in Section 1.2.5 and involve unacceptable cancer risks to residents using groundwater for drinking, cooking, and showering on the order of 10^{-3} to 10^{-6}.

In addition to evaluating risks, a comparison to the applicable or relevant and appropriate requirements (ARARs) was made as part of the no action alternative. In the residential wells, the maximum concentration of trichloroethene (TCE) exceeds its maximum contaminant level (MCL) and both the geometric mean and maximum concentrations exceeded its maximum contaminant level goal (MCLG). In the monitoring wells, the maximum concentration of TCE exceeds its MCL and both the geometric mean and maximum concentrations exceeded its MCLG. The maximum concentration of 1,1-dichloroethene exceeds both its MCL and MCLG. The geometric mean and maximum concentrations of dieldrin in the monitoring wells exceed the ambient water quality criteria (AWQC) for this chemical corresponding to the 10^{-6} excess lifetime cancer risk level. In both the residential and monitoring wells, the geometric mean and maximum concentrations of tetrachloroethene exceed the proposed MCLG of zero. Based on these comparisons, consumption of groundwater at the Croydon TCE Site will be associated with some adverse health effects which will remain under the no action alternative.

This alternative does not reduce the toxicity, mobility, or volume of the waste. Also, it is very unlikely that the state or the community would accept no action at the Croydo AR301494

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TABLE 4-1

FACTORS FOR DETAILED ANALYSIS OF ALTERNATIVES
CROYDON TCE SITE

Short-Term Effectiveness	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume	Implementability
Time until protection is achieved.	Reduction of existing risks.	Amount of hazardous materials destroyed or treated.	Ability to operate and construct the technology.
Short-term reliability of technology.	Magnitude of future risks.	Degree of expected reductions in toxicity, mobility, and volume.	Ability to phase into operable units.
Protection of community during remedial actions.	Long-term reliability.	Degree to which treatment is irreversible.	Ease of undertaking additional remedial actions if necessary.
Protection of workers during remedial actions.	Prevention of future exposure to residuals.	Type and quantities of residuals remaining after treatment.	Ability to monitor effectiveness of remedy.
	Potential need for replacement.		Ability to obtain approvals from other agencies.
			Coordination with other agencies.
			Availability of treatment, storage, and disposal services and capacity.
			Availability of necessary equipment and specialists.

TABLE 4-1
FACTORS FOR DETAILED ANALYSIS OF ALTERNATIVES
CROYDON TCE SITE
PAGE TWO

Cost	Compliance with ARARs	Overall Protection	State Acceptance*	Community Acceptance*
Development and Construction Costs. Operating costs for implementing remedial action. Other capital and short-term costs until remedial action is complete. Costs of operation and maintenance for as long as necessary. Costs of 5-year reviews (if required).	Compliance with contaminant-specific ARARs. Compliance with some location-specific ARARs. Compliance with some action-specific ARARs. Compliance with other criteria, advisories, and guidance.	How alternative provides human health and environmental protection.	Features of the alternative the state supports. Features of the alternative the state has reservations about. Features of the alternative the state strongly opposes.	Features of the alternative the community supports. Features of the alternative the community has reservations about. Features of the alternative the community strongly opposes.

* Only preliminary assessments in FFS. These criteria will be fully assessed in the ROD following the public comment period.

Since no site activities are proposed under this alternative, evaluation of effectiveness, implementability, and cost are not performed.

4.2 REMEDIAL ALTERNATIVE 2 - CONNECTION TO PUBLIC WATER SYSTEM WITH MONITORING

4.2.1 Description

This alternative involves the construction of new water service lines, mains, hydrants, and valves and the connection to the Borough of Bristol Water and Sewage Department supply mains (see Figure 2-1). The intent of this alternative is to eliminate the present and future health risks associated with potable and nonpotable use of contaminated groundwater. The only street within the zone of groundwater contamination without a water main is Belleview Avenue. Only two homes are located along this street. One household is connected to a water main from an adjacent street. The other household is not serviced. In addition to this household, 12 other households throughout the study area are not serviced by the public water supply. These homes are located along streets with an existing water main. For one reason or another, these homes are not connected to the water main along their street or adjacent streets.

It is recommended that the homes without the services of a public water supply be verified for number, location, and usage prior to designing this remedial action. This is necessary because the township has just recently installed water lines along five streets within the study area and it is possible that the township may continue to expand the water service.

This alternative involves installing ductile iron water mains of the same size as the existing mains and 3/4 inch diameter copper service lines with curb box and valve for each connected residence. EPA will not be responsible for the operation and maintenance of the water supply system once it is operational. EPA will transfer control of the new water lines to the Borough of Bristol Water and Sewage Department as soon as construction is complete. Therefore, construction details (i.e., diameter of lines, spacing of fire hydrants, etc.) must meet the requirements of the Borough of Bristol and local fire codes.

This alternative also involves groundwater monitoring to ensure that homes located outside of the TCE contaminated zone without public water will not be at risk. At present, homes located west of Central Avenue without public water are not affected by the groundwater contamination since the plume is migrating in a south-southeast direction. Monitoring wells and residential wells located west of Harris Avenue did not exhibit TCE contamination. As a safeguard, however, a limited number of residential wells west of the plume (approximately 7 wells) that depend on groundwater will be sampled annually to confirm the absence of groundwater contamination in this area. Samples shall be analyzed for trichloroethene (TCE), tetrachloroethene

(PCE), vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethene.

4.2.2 Short-Term Effectiveness

This alternative could be implemented relatively quickly to mitigate health risks under both present and future conditions. The estimated construction time for installation of additional water lines in the community of Croydon is approximately 1 month.

The technologies involved to connect to the public water system are well established and use common engineering and construction practices. Generally, public water systems are very reliable and require only minimal maintenance.

This alternative has no apparent occupational or community health risks associated with implementation. The low probability of construction-type accidents associated with heavy equipment operation and material handling are not a major consideration. Occupational exposure during construction is not anticipated, but could be readily controlled using conventional health and safety techniques. Environmental receptors should not be affected by short-term excavation and installation activities.

4.2.3 Long-Term Effectiveness and Permanence

This alternative meets the focused objective of eliminating the present and future health risks associated with potable and nonpotable use of the contaminated groundwater.

This alternative provides long-term reliability and any maintenance required to the water mains would be provided by the Borough of Bristol Water and Sewage Department. Maintenance of the water service lines (on private property) is the responsibility of the property owner, but this would be minimal.

This study does not address the cleanup of the groundwater and exposure to residuals, because of the focused nature of this FS. However, a forthcoming FS will address the restoration of the groundwater and other effected media.

Those residents who elect to continue to use their private wells for nonpotable and non-showering purposes are not expected to incur any significant risk (see Section 4.2.7, Overall Protection of Human Health and the Environment).

4.2.4 Reduction of Toxicity, Mobility, and Volume

Because of the focused nature of this FS, this alternative does not address the reduction of the source of contamination, toxicity, mobility, and volume of contamination; however, a forthcoming FS will address remediation of the groundwater.

4.2.5 Implementability

The technologies associated with this alternative are well-established and use common engineering and construction practices. There will be no need to monitor the effectiveness of the remedy, since the public water supply is regulated under the Safe Drinking Water Act.

This alternative will require the approval of the Borough of Bristol Water and Sewage Department. Since the water department currently has excess capacity and the proposed water hook-ups are within the corporate boundaries of Croydon, no opposition is anticipated by the water department. The construction of the new water main and service lines would require the coordination of EPA and the water department to insure the new construction complies with the design and construction standards of the water department.

The Borough of Bristol Water and Sewage Department presently provides water treatment for their service area and has adequate capacity to provide the 13 proposed new water connections to their system. It is estimated that the proposed new water connections would increase the existing demand by 4,550 gallons per day, based on average flow (13 dwellings x 3.5 residents per dwelling x 100 gallons per day per resident).

4.2.6 Compliance with ARARs

The alternate water supply can be furnished by the Borough of Bristol Water and Sewage Department once the installation of the new water main and individual service lines are completed. By connecting to the public water system, the water quality will be regulated by the National Primary Drinking Water Regulations and thus be in compliance with the health-based ARARs for the Croydon TCE Site.

4.2.7 Overall Protection of Human Health and the Environment

Implementation of this alternative would eliminate the health risks associated with exposure to contaminated groundwater. Public health would be protected since the potential for ingestion and dermal contact of contaminated groundwater, and inhalation of volatile organic compounds at concentrations greater than the National Primary Drinking Water Standards released while using the water for household uses would be eliminated. This remedial alternative will not address protection of environmental receptors or risks resulting from exposure to media other than groundwater. A forthcoming FS will address these issues.

The residents within the study area who elect to continue to use their private wells for nonpotable purposes are not expected to incur any significant risk. Nonpotable water uses, such as car washing and watering of lawns, will result in short term exposure to the contaminants present in the groundwater. Both inhalation of volatile organics released from the groundwater and dermal contact with the groundwater with the potential for absorption through the skin are possible exposure routes. However, these exposures will be short term and should not result in significant risks in comparison to those determined in the public health evaluation. Any volatiles that are released during these activities will be rapidly diffused into the outdoor air and highly diluted resulting in minimal exposure. Dermal exposures will also be minimal due to the short exposure durations (e.g., minutes) relative to the amount of time it typically takes to reach steady state absorption across the skin (Scheuplein and Blank, 1969). In addition, the competing reactions of volatilization and absorption will occur on the very thin film of water that will result on the skin. It is probable that since volatilization represents the path of least resistance, it will be the preferred reaction.

If some residents wish to use their private well in addition to having the services of public water, the homeowner must ensure that cross-contamination will not occur. Otherwise, the private well will be sealed once the public water service is installed.

The sealing of private wells will be implemented as follows. Clean sand, clay, or gravel will be placed in screened wells within the screened interval, followed by cement grout or neat cement. For open hole rock wells, the holes will be filled with clean sand, clay, or gravel to 10 feet below the casing, followed by a 1 to 2 foot bentonite seal before completing the hole with cement grout or neat cement. The capital cost for sealing (including all construction and mark-ups) is estimated at approximately $350 per well and is based on a 4-inch diameter well at a depth of 35 feet.

A public health issue of concern is the groundwater control required for future residential development in the contaminated zone. Specifically, the development of new residential wells within the TCE contaminated zone should be restricted. In order to prevent new wells from being constructed, a zoning ordinance which restricts access to a polluted aquifer may be employed. However, it does not appear that any municipal entity within Pennsylvania has adopted an ordinance either generally prohibiting the withdrawal of water for any purpose, or specifically for the purpose of human consumption (EPA, 1986).

It should also be noted that Superfund only corrects problems within an existing system and does not include projections for future growth. If an expanded remedy is desired by the State or locality for fund-financed remedial actions, the State will generally have to pay the incremental cost and the remedy must then be implemented as a State-lead action.

4.2.8 State and Community Acceptance

The state and community will most likely support this alternative. If new connections are outside the community's corporate boundaries, water rates may be regulated by a Public Utility Commission (PUC). If the community becomes regulated because of the new connections, there may be some opposition from the community. Since the existing public water system is presently serving both the communities of Bristol and Croydon, this should not be a concern; however, some residents may object to paying for water which was once free to them. State and community acceptance should be evaluated more thoroughly in the EPA Record of Decision once the public has the opportunity to comment on the proposed alternatives.

4.3 REMEDIAL ALTERNATIVE 3 - INDIVIDUAL WELL TREATMENT WITH GAC AND WITH MONITORING

4.3.1 Description

This alternative involves the installation of a granular activated carbon (GAC) treatment unit in each of the 13 homes using private wells in the groundwater contamination zone (see Figure 2-1). The intent of this alternative is to reduce the present and future health risks associated with the potable and nonpotable use of contaminated groundwater.

This alternative involves the installation of a granular activated carbon (GAC) treatment unit on each individual residential well. As with any treatment system, the GAC design should be developed on the adequate characterization of the influent and pilot testing. The following described system is subject to modification upon the development of more data.

A 10 gallon carbon capacity pressure unit is proposed to provide for the necessary contact time and the anticipated carbon use rate. The unit would be fed by the existing well pump and would feature an automatic-timer-operated backwash cycle to remove solids that accumulate.

In order to provide proper operation and maintenance of the units, a contractor service is required. Replacement of the carbon is anticipated approximately every 6 months with the vendor responsible for hauling the spent carbon, and either disposing or treating it properly since it would contain TCE and other contaminants.

Groundwater monitoring of the GAC effluent will be required as part of this alternative to verify that the system is operating properly. Since contaminant concentrations may increase and new contaminants may appear that cannot be effectively treated by the GAC treatment (e.g., vinyl chloride), a limited number of monitoring wells will be monitored annually. These wells, which are located within the groundwater contamination zone, include: CR-23-53, CR-23-32, MW6(S), MW6(D), MW8(S), and MW8(D). Additionally, a limited number of residential wells (7 wells) along Grant and Linton Avenues will be monitored annually to confirm the absence of groundwater contamination west (outside

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of) of the groundwater contamination zone. Under this alternative, the following monitoring activities would occur:

- Quarterly monitoring of each GAC effluent (13 private wells) and analysis for target volatile organics including; TCE, PCE, vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethene.

- Annual monitoring of 6 monitoring wells to evaluate groundwater changes (same analytical parameters as above).

- Annual monitoring of 7 residential wells along Grant and Linton Avenue to confirm absence of groundwater contamination (same analytical parameters as above).

4.3.2 Short-Term Effectiveness

This alternative could be implemented relatively quickly to mitigate health risks under both present and future conditions. The estimated construction time the installation of GAC units in the 13 homes located in the area of concern is approximately 5 weeks. This construction estimate does not include pilot testing.

Generally, GAC can remove a broad range of organics from drinking water. However, its effectiveness depends on the specific chemicals present, their concentration, and the required degree of removal. Trace levels (less than 0.2 µg/l) of vinyl chloride have been observed in two of the residential wells and vinyl chloride is also a breakdown product of TCE. GAC treatment is not a feasible technology for treating vinyl chloride. The MCL for vinyl chloride is 2 µg/l and the MCLG is zero. Since the observed trace levels are less than the MCL, the GAC treatment would be effective on the short term; however, the groundwater must be monitored prior to treatment on a regular basis to detect any increase in contaminant concentrations or occurrences, particularly vinyl chloride.

This alternative has no apparent occupational or community health risks associated with implementation. Occupational exposure during installation of the treatment units is not anticipated, but could be readily controlled using conventional health and safety practices.

4.3.3 Long-Term Effectiveness and Permanence

Implementation of this alternative would reduce the health risks associated with exposure to contaminated groundwater, but would not eliminate all risks since future contaminants may increase in concentration or new contaminants may appear that cannot be effectively treated by GAC units (such as vinyl chloride). Although GAC units generally have a removal efficiency of between 60-90 percent for most organic chemicals, it is apparent that these treatment systems will be ineffective in mitigating

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long-term human exposure through groundwater use, should non-removable contaminants arrive at the receptor wells. Additionally, if contaminant concentrations increase significantly, the contamination may exhaust the carbon supply, permitting contaminants to pass through untreated. Thus, monitoring of both groundwater and treatment effluent is required to indicate the presence or absence of contaminants (i.e., TCE, vinyl chloride) in the wells.

Because of the focused nature of this report, it does not address exposure to contaminant residuals. This will be addressed in the forthcoming FS.

In order to provide proper operation and maintenance of the units, a contractor service is required. Replacement of the carbon is anticipated approximately every 6 months. The vendor would be responsible for hauling the spent carbon for subsequent treatment or disposal. This requirement may be a problem since under normal conditions, the spent carbon is left by the vendor with the homeowner for subsequent disposal.

4.3.4 Reduction of Toxicity, Mobility, and Volume

Because of the focused nature of this FS, this alternative does not address the reduction, mobility, or volume of the source of contamination; however, a forthcoming FS will address remediation of the groundwater. The toxicity of the contaminants will only be reduced at the point of exposure.

4.3.5 Implementability

The technologies associated with installing individual treatment systems and maintaining the systems use common engineering and construction practices. Pilot testing would be required for the design of the treatment systems, but as discussed in Section 4.3.2, this should not cause a significant delay in implementing this alternative.

As indicated in Section 4.3.3, monitoring of the groundwater and treatment effluent is required to check the effectiveness of the remedy. Should non-removable contaminants arrive at the residential wells (e.g., vinyl chloride), the individual treatment units cannot be modified to treat these contaminants.

Under this alternative, Right of Entry Agreements would be required between EPA and the private property owners for the following:

- To sample 7 residential wells located west of the groundwater contamination zone.
- To sample 6 monitoring wells within the zone of groundwater contamination zone.

- To install 13 GAC treatment systems;
- To sample GAC effluent and provide maintenance of units on a periodic basis.

The availability of equipment and specialists to install and service the treatment units may present a problem since the vendor would be responsible for hauling away the spent carbon and disposing or treating it properly. Normally, the spent carbon is left with the homeowner.

4.3.6 Compliance with ARARs

The installation of individual well treatment units in the homes using private wells should satisfy the applicable drinking water standards, based on the current contaminants and degree of contamination in the residential wells. Should non-removable contaminants such as vinyl chloride occur in concentrations greater than the MCL (2 µg/l) in the residential wells, then this alternative would not comply with the ARARs for the Croydon TCE Site.

4.3.7 Overall Protection of Human Health and the Environment

Implementation of this alternative would reduce the health risks associated with exposure to contaminated groundwater, but would not eliminate all risks since future contaminants may increase in concentration or new contaminants may appear that cannot be effectively treated by GAC units (such as vinyl chloride). Additionally, since it does not address remediation of the contaminated groundwater, a private well could be installed in the future and, without treatment, exposure to contaminants would occur.

Implementation of this alternative will result in a decrease in the contaminant levels in groundwater used in the home. The effectiveness of this alternative is based on the assumptions that the granulated activated carbon filter will operate at peak efficiency and adequate maintenance will be performed. If the filter is not replaced as scheduled (i.e., every 6 months), contaminant breakthrough could occur and exposure to the contaminants present in the groundwater at levels greater than or equal to the original concentrations could result.

Once the activated carbon becomes saturated, it will be replaced by a permitted vendor. This may introduce short term risks associated with the removal and disposal of the spent carbon. However, proper health and safety measures can be taken to avoid this potential problem.

Because of the focused nature of this report, this alternative does not address the protection of the environment, but a forthcoming FS will address this issue.

4.3.8 State and Community Acceptance

State and community acceptance of this alternative is questionable. EPA will not be responsible for the long-term operation and maintenance of the treatment system once it is operational. EPA will seek transfer of control as soon as construction is complete. Control will generally be transferred to local authorities. The local authorities will most likely not want to accept this additional expense and the community may fear that the O&M costs will be imposed upon them by the local authorities. Since monitoring of the groundwater and effluent is also required under this alternative, a similar situation would exist with costs associated with collecting samples and providing analysis. EPA would pay for the operation and maintenance cost of monitoring for the first year. These costs thereafter would be the responsibility of the State.

4.4 COST EVALUATIONS

The cost analysis for the remedial alternatives involves the following:

- Capital Cost Estimation
- Operation and Maintenance (O&M) Cost Estimation
- Present-Worth Analysis

Capital Costs are those expenditures that are initially incurred to develop and incorporate a remedial action. Capital costs consist of direct and indirect costs.

O&M Costs are those required to operate and maintain the remedial action throughout its lifetime.

Present-Worth Analyses discount expenditures that occur over different time periods to the present year. A 30-year project life, 5 percent discount rate, and zero inflation are used in the analyses.

The method for estimating considers unit costs and construction quantity estimates. Unit costs were assigned to the work quantities considering the materials required, the types of equipment to be used, and the construction difficulty expected. Labor and equipment costs are adjusted, if required, to reflect construction difficulty and diminished productivity associated with higher levels of health and safety protection required or hazardous work items.

Cost estimates have been prepared in detail for each of the three alternatives. These estimates are summarized in Table 4-2 and discussed below. Appendix B presents additional detailed information regarding the development of these costs.

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TABLE 4-2

REMEDIAL ACTION ALTERNATIVE COST SUMMARY
CROYDON TCE SITE

Remedial Action Alternative	Sensitivity Cost Item	Capital Costs (1000s)	Annual O&M Costs (1000s) (Includes Monitoring)		Present Worth Costs (1000s)
			Years 1-5	Years 6-30	
No. 1 - No Action	Not Applicable	-0-	-0-	-0-	-0-
No. 2 - Alternate Water Supply	Number of homes to be serviced with public water is estimated to be 13.	53.6	3.4	3.4	106
	A sensitivity high range of 50 percent was used.	69.1	3.4	3.4	121
No. 3 - Individual Well Treatment with GAC	Number of homes to be treated is estimated to be 13.	64.5	29.9	10.7	312
	A sensitivity high range of 50 percent was used.	89.2	39.2	14.3	417

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4.4.1 Alternative No. 1 - No Action

This alternative will not require any implementation of remedial activities, therefore cost evaluations are not applicable.

4.4.2 Alternative No. 2 - Alternative Water Supply With Monitoring

The capital, O&M, and present worth costs for this alternative are outlined in Table 4-2. Baseline and high sensitivity cost estimates have been developed for this alternative. The baseline estimate of 13 homes (to be serviced with public water) is based on information provided to the REM III Project Team by the Borough of Bristol Water and Sewage Department. The high sensitivity cost estimate for this alternative assumes that 7 more residential wells (i.e., a total of 20 residential wells) will be connected to the public water supply. Since no "door to door" check or survey was made throughout the area of concern, and the number of "non-serviced" households was provided by the water department, it is possible that more homes along "serviced" streets are without public water. A 50 percent sensitivity factor provides for error in the water department's records. As previously mentioned, the location and number of non-serviced households should be verified prior to designing this remedial alternative. Detailed cost information is provided in Appendix B.

4.4.3 Alternative No. 3 - Individual Well Treatment with GAC and with Monitoring

Table 4-2 outlines the capital, O&M, and present worth costs for this alternative. The baseline and high sensitivity cost estimates are based on 13 GAC units and 20 GAC units, respectively. The rationale for estimating the number of affected households is the same as for Alternative No. 2. Detailed cost information is provided Appendix B.

4.5 SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES

Table 4-3 provides a summary and comparison of each alternative with respect to the nine criteria.

TABLE 4-3

SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Short Term Effectiveness	Not Applicable	Public water systems are very reliable and require only minimal maintenance. Construction time is estimated to be 1 month.	Effectiveness is dependent on the specific chemicals present, their concentration, and the required degree of removal. GAC would be effective at the Croydon TCE Site, but monitoring of the effluent and TCE plume is required. Estimated construction time for installation of GAC units is 5 weeks.
Long Term Effectiveness and Permanence	Not Applicable	This alternative provides long-term reliability and any maintenance required would be the responsibility of the Borough of Bristol Water and Sewage Department. Maintenance of the water service lines on private property would be the responsibility of the homeowner, but this should be minimal.	For the contaminants detected at the site, GAC would be effective in reducing the concentration to acceptable levels. Future release of contaminants may increase in concentration or new contaminants may appear that cannot be effectively treated by GAC units (vinyl chloride). If contaminant concentrations increase significantly, the contamination may exhaust the carbon supply. Therefore, monitoring of both the groundwater and the treated effluent is required. For optimum operation, replacement of the carbon filter is necessary approximately every 6 months.

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TABLE 4-3
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE TWO

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility, or volume since no treatment or action is involved.	This alternative will eliminate exposure to contamination, but will not reduce the level of contamination in the groundwater. A forthcoming FS will address remediation of the groundwater plume and the source of contamination, if identified.	Reduction in toxicity at the exposure point is achieved. A forthcoming FS will address remediation of the groundwater plume and the source of contamination, if identified.
Implementability	Not Applicable	This alternative will need the approval of the Borough of Bristol Water and Sewage Department since EPA will transfer control once the operation begins. The Borough of Bristol Water and Sewage Department has adequate capacity to include the proposed number of new customers. Construction of the new water lines would not be difficult since existing lines are located throughout the area.	Availability of equipment and technicians to install and service the treatment units may present a problem since the vendor would be responsible for hauling the spent carbon away and disposing of it properly. Pilot testing would be required. Monitoring of the plume and GAC effluent would also be required. Right of Enter Agreements are necessary to install, service, and monitor the GAC units.
Compliance With ARARs	Does not meet ARARs	The Borough of Bristol water supply is regulated by the National Primary Drinking Water Regulations. Health-based ARARs (at the exposure point) will be satisfied. Groundwater contamination will remain, but this will be addressed in a forthcoming FS.	Health-based ARARs would be met (at the exposure point), but monitoring of the effluent is necessary to confirm that non-removable contaminants such as vinyl chloride do not appear in concentrations greater than the MCL (2 μg/l). Groundwater contamination will remain, but this will be addressed in a forthcoming FS.

TABLE 4-3
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE THREE

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Overall Protection of Human Health and the Environment	Public health risks will go unabated since no remedial action is undertaken. At present, there is a risk to groundwater users.	Implementation of this alternative would eliminate the health risks associated with groundwater exposure. This remedial alternative will not address protection of environmental receptors or risks resulting from exposure to media other than groundwater. A forthcoming FS will address these issues. Residents within the area who continue to use their groundwater for nonpotable purposes (i.e., watering the lawn) are not expected to incur any significant risk since exposure would be minimal. However, if residents wished to operate their private well in addition to having the services of a public water supply, the homeowner will be required to ensure that cross-contamination will not occur. Otherwise, the private wells will be sealed. A limited amount of groundwater monitoring will be necessary to ensure that homes located outside of the TCE contaminated zone without public water will not be at risk.	Health risks associated with exposure to contaminated groundwater would be reduced to acceptable levels, but would not eliminate all risks since future contaminants may increase in concentration or new contaminants may occur that cannot be effectively treated (i.e., vinyl chloride). Periodic replacement of the carbon filter is necessary or contaminant breakthrough could occur and exposure to contaminants would result in an unacceptable health risk. This remedial alternative will not address protection of environmental receptors or risks resulting from exposure to other media. A forthcoming FS will address these concerns.

TABLE 4-3
SUMMARY MATRIX FOR DETAILED EVALUATION OF ALTERNATIVES
CROYDON TCE SITE
PAGE FOUR

Criteria	Remedial Alternatives		
	No. 1 No Action	No. 2 Alternate Water Supply	No. 3 Individual Well Treatment With GAC
Community and State Acceptance	It is very unlikely that the State or community would accept this alternative.	The state and community will most likely accept this alternative. Some homeowners may object to the fact that they will have to pay for the public water.	Questionable. EPA will seek transfer of control as soon as construction is complete. Local or state authorities will most likely not want to accept the expense of monitoring and servicing the GAC units. Community will fear that the O&M costs will be imposed upon them by the local authorities.
Cost(1)			
• Baseline Capital	-0-	$53,562	$64,496
• O&M (annual)(2)	-0-	$3,420	$29,900
• Baseline Present Worth(3)	-0-	$106,000	$312,000

(1) Sources include vendor estimates and Means 1988 - Site Work Data.
(2) Value represents years 1-5 only.
(3) Baseline present worth calculated for O&M period of 30 years.

REFERENCES

AR301512

REFERENCES

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Scheuplein, R J, Blank, J H, Braurer, C J, MacFarlane, D J, 1969. Percutaneous Absorption of Steriods. Journal of Investigative Dermatology. 54:63-70.

Wright, D, 1988. Telecon Note Between Dennis Wright of Middle Atlantic States Engineering and Willis C Isner of NUS Corp. May 12, 1988.

AR301513

APPENDICES

AR301514

A

AR301515

APPENDIX A

PRELIMINARY DESIGN CALCULATIONS
FOR GRANULAR CARBON FILTRATION UNITS

CLIENT: EBASCO	FILE NO.: 621 Y1553 . 09	BY: JLG	PAGE 1 OF 3
SUBJECT: CROYDON TCE DOMESTIC WATER TREAT		CHECKED BY: [illegible]	DATE: 5/22/88

1.0 DESIGN BASIS

1.1 Flow : Typical Household with 4-5 people @ 80 GPD/person or 400 GPD / Household

Instantaneous flow : 2 faucets simultaneously - 8GPM

1.2 Contaminants

- TCA (Trichloroethane) = 0.025 mg/l
- TCE (Trichloroethylene) = 0.1 mg/l
- TSS = assume 1.0 mg/l or less
- TOC = 5 mg/l

2.0 TREATMENT SCHEME

Use Individual household-type Granular Activated Carbon (GAC) contactors to treat the water supply of each individual well

3.0 GAC ADSORPTION

From USEPA Document 600/8-80-023 ("Carbon Adsorption Isotherms for Toxic Organics")

GAC requirement for TCA @ 0.025 mg/l = 40 mg GAC/liter water

TCE @ 0.1 mg/l = 15 mg GAC/liter water

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Total expected usage from specific contaminants = 55 mg GAC/liter water treated

NUS CORPORATION AND SUBSIDIARIES — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE
EBASCO	621Y/553.09	JLG	PAGE 2 OF 3
SUBJECT: CROYDON TCE		CHECKED BY:	DATE: 5/22/88

GAC will also adsorb other constituents of TOC. Rule of thumb is 0.1 pound of TOC removed per pound of GAC or 10 mg GAC used per mg TOC removed.

Total expected usage from TOC removal = 10 mg GAC × 5 mg TOC = 50 mg GAC per liter of water to be treated

Specific contaminant requirement is higher and thus will govern design

Estimated GAC usage: 55 mg × 400 GPD × 3.785 l/Gal ÷ 453,600 mg/lb
= 0.18 lbs GAC / day per household

4.0 CONTACTOR DESIGN

Design contactor on basis of 10 GPM/Ft² percolation rate

→ Percolation surface: 8 GPM ÷ 10 GPM/Ft² = 0.8 Ft² or 115 in²
→ Contactor diameter = $\sqrt{\frac{115 \times 4}{\pi}}$ = 12.1 inch

Closest commercially available unit is Culligan 12 inch household filter

GAC volume = 1.0 CuFt & 50 lbs

. Check contact time at peak flow : 1.0 × 7.485 ÷ 8.0 = 0.93 min OK

. Check frequency of GAC replacement @ 90% usage

50 × 0.9 ÷ 0.18 = 250 days or 8.3 months OK

. Check backwash frequency @ 1 mg/l TSS & 0.25 lbs/Ft² specific loading

AR301518

0.78 × 0.25 ÷ (400 × 1.0 × 8.34 × 10^{-6}) = 58 days OK

NUS CORPORATION AND SUBSIDIARIES			STANDARD CALCULATION SHEET
CLIENT: EBASCO	FILE NO.: 621Y 1553.09	BY: JLG	PAGE 3 OF 3
SUBJECT: CROYDON TCE		CHECKED BY: KCT	DATE: 5/22/88

5.0 COST

- Per Calligan, price of GAC contactor is about $1200.
- @ $2.00 /lb GAC. Estimated cost of GAC replacement:

$$50 \times 2.00 \times 12 \div 8.3 = \$\ 145/yr$$

AR301519

B

AR301520

APPENDIX B

CALCULATIONS FOR COST ESTIMATES

NUS CORPORATION AND SUBSIDIARIES			STANDARD CALCULATION SHEET
CLIENT: Ebasco/EPA	FILE NO.: 6214	BY: R.P. Wattras	PAGE 1 OF 2
SUBJECT: Croydon TCE Site-Alternative No. 2		CHECKED BY: A. M. FINKE	DATE: 9-14-88

Quantities for Alternative No. 2 - Connection to Public Water Supply

6" Water Mains (ductile iron)

Belleview Ave. 270'
Total 270' L.F.

Fire Hydrants

Belleview Ave. 1
Total 1

6" valve and curb box

Belleview Ave. 1
Total 1

3/4" Service Lines (copper)

Assume 50 L.F. required for each residence

Total of 13 residences x 50'/ea = 650 L.F.

Corporation Stops and Curb Boxes (3/4" Ø, Copper Outlet)

Total = 1 per residence x 13 residences = 13 ea.

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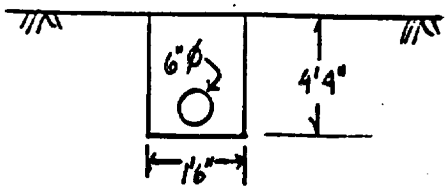
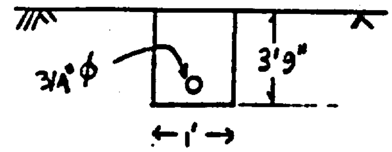
NUS CORPORATION AND SUBSIDIARIES — **STANDARD CALCULATION SHEET**

CLIENT: Ebasco/EPA	FILE NO.: 6214	BY: R P Wattras	PAGE 2 OF 2
SUBJECT: Croydon TCE Site - Alternative No. 2		CHECKED BY: A. M. Finka	DATE: 9/14/88

Excavation





A = 3.75 S.F.

A = 6.495 S.F.

Total = [(270')(6.495 □') + (650')(3.75 □')] 1/27 = 155 c.y.

Pavement Replacement

Total = (270')(1.5')(1/9) = 45 s.y.

Bedding

For 6" φ pipe, 14" depth A = (1.5)(1.167') − π/4 (.25') = 1.55 s.F.
For 3/4" φ pipe, 5" depth A = (1.0)(0.417') − π/4 (.004') = 0.414 s.F.

Total = [(270')(1.55 □') + (650')(0.414 □')] (1/27) = 25 C.Y

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CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No. 2 (Baseline)
(CTCEWS2)

Item	Qty	Unit	Cost Sub.	Cost Mat.	Cost Labor	Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
1) Water Main												
a) 6 " Ductile Iron Pipe	270	LF		9.75	5.40			2633	1458		4091	
b) Excavation and Backfill	270	LF			4.55	2.67			1229	721	1949	4' Depth
c) Pipe Bedding	270	LF		1.35	1.89			365	510		875	
d) 6" Valve and Curb Boxes	1			770.00	60.00	5.00		770	60	5	835	
2) Fire Hydrant Including Gate Valve and Box	1			2550.00	680.00			2550	680		3230	4' Depth
3) Home Service Line Including 50'- 3/4" Copper Tubing, Corporation Stop and Curb Box	13			225.00	585.00			2925	7605		10530	4' Depth
4) Paving Replacement	45	SY		13.30	1.25	.95		599	56	43	698	
							0	9841	11598	769	22207	
Burden @ 13% of Labor Cost									1508		1508	
Labor @ 15% of Labor Cost									1740		1740	
Material @ 5% of Material Cost								492			492	
Subcontract @ 10% of Sub. Cost							0				0	
Total Direct Cost							0	10333	14846	769	25947	
Indirects @ 75% of Total Direct Labor Cost									11134		11134	
Profit @ 10% Total Direct Cost											2595	
Total Field Cost											39675	
Contingency @ 20% of Total Field Cost											7935	
Engineering @ 15% of Total Field Cost											5951	
TOTAL PROJECT COST											53562	

AR301524

CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No. 2 (Sensitivity High Range)
(CTCEWS2H)

			Cost				Total Cost				Total	
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	Direct Cost	Comments
1) Water Main												
a) 6 " Ductile Iron Pipe	270	LF		9.75	5.40			2633	1458		4091	
b) Excavation and Backfill	270	LF			4.55	2.67			1229	721	1949	4' Depth
c) Pipe Bedding	270	LF		1.35	1.89			365	510		875	
d) 6" Valve and Curb Boxes	1			770.00	60.00	5.00		770	60	5	835	
2) Fire Hydrant Including Gate Valve and Box	1			2550.00	680.00			2550	680		3230	4' Depth
3) Home Service Line Including 50'- 3/4" Copper Tubing, Corporation Stop and Curb Box	20			225.00	585.00			4500	11700		16200	4' Depth
4) Paving Replacement	45	SY		13.30	1.25	.95		599	56	43	698	
							0	11416	15693	769	27877	
Burden @ 13% of Labor Cost									2040		2040	
Labor @ 15% of Labor Cost									2354		2354	
Material @ 5% of Material Cost								571			571	
Subcontract @ 10% of Sub. Cost							0				0	
Total Direct Cost							0	11986	20087	769	32842	
Indirects @ 75% of Total Direct Labor Cost									15065		15065	
Profit @ 10% Total Direct Cost											3284	
Total Field Cost											51192	
Contingency @ 20% of Total Field Cost											10238	
Engineering @ 15% of Total Field Cost											7679	
TOTAL PROJECT COST											69109	

AR301525

CROYDON TCE SITE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No. 3 (Baseline)
(CTCEWT3)

Item	Qty	Unit	Cost Sub.	Cost Mat.	Cost Labor	Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
1) GAC Contactor Pilot Test		LS	11000.00				11000				11000	
2) Granular Activated Carbon Contacter	13			1200.00	300.00			15600	3900		19500	
3) Grout Abandoned Wells	13		350.00				4550				4550	
							15550	15600	3900	0	35050	
Burden @ 13% of Labor Cost									507		507	
Labor @ 15% of Labor Cost									585		585	
Material @ 5% of Material Cost								780			780	
Subcontract @ 10% of Sub. Cost							1555				1555	
Total Direct Cost							17105	16380	4992	0	38477	
Indirects @ 75% of Total Direct Labor Cost									3744		3744	
Profit @ 10% Total Direct Cost											3848	
Total Field Cost											46069	
Contingency @ 20% of Total Field Cost											9214	
Engineering @ 20% of Total Field Cost											9214	
TOTAL PROJECT COST											64496	

AR301526

CROYDON TCE SITE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No. 3 (Sensitivity High Range)
(CTCEWT3H)

Item	Qty	Unit	Cost Sub.	Cost Mat.	Cost Labor	Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
1) GAC Contactor Pilot Test		LS	11000.00				11000				11000	
2) Granular Activated Carbon Contacter	20			1200.00	300.00			24000	6000		30000	
3) Grout Abandoned Wells	20		350.00				7000				7000	
							18000	24000	6000	0	48000	
Burden @ 13% of Labor Cost									780		780	
Labor @ 15% of Labor Cost									900		900	
Material @ 5% of Material Cost								1200			1200	
Subcontract @ 10% of Sub. Cost							1800				1800	
Total Direct Cost							19800	25200	7680	0	52680	
Indirects @ 75% of Total Direct Labor Cost									5760		5760	
Profit @ 10% Total Direct Cost											5268	
Total Field Cost											63708	
Contingency @ 20% of Total Field Cost											12742	
Engineering @ 20% of Total Field Cost											12742	
TOTAL PROJECT COST											89191	

AR301527

CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No. 2 (Baseline)
Post Remedial Monitoring
(O&MCS2)

Annual Costs

ITEM	ITEM $ ANNUAL SAMPLING	NOTES
1. Sampling	1620.00	7 groundwater samples, 32 manhours per sampling period plus travel, living and sample shipping costs
2. Analysis	900.00	9 samples per sampling period (incl. blank and duplicate), volatile organic (EPA 601/SW 8010)
3. Reporting	900.00	Annual reports 20 manhours per report
TOTAL ANNUAL COST	3420.00	Post remedial monitoring will be performed annually for years 1 thru 30

CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No. 2 (Sensitivity High Range)
Post Remedial Monitoring
(O&MCS2H)

Annual Costs

ITEM	ITEM $ ANNUAL SAMPLING	NOTES
1. Sampling	1620.00	7 groundwater samples, 32 manhours per sampling period plus travel, living and sample shipping costs
2. Analysis	900.00	9 samples per sampling period (incl. blank and duplicate), volatile organic (EPA 601/SW 8010)
3. Reporting	900.00	Annual reports 20 manhours per report
TOTAL ANNUAL COST	3420.00	Post remedial monitoring will be performed annually for years 1 thru 30

CROYDON TCE SITE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No. 3 (Baseline)
Post Remedial Monitoring
(O&MCS3)

Annual Costs

ITEM	ITEM $ QUARTERLY SAMPLING	ITEM $ ANNUAL SAMPLING	NOTES
1. Sampling	12000.00	3000.00	13 groundwater samples, 13 residential samples, 60 manhours per sampling period plus travel, living and sample shipping costs
2. Analysis	11200.00	2800.00	28 samples per sampling period (incl. blank and duplicate), volatile organic (EPA 601/SW 8010)
3. Reporting	3600.00	1800.00	Quarterly reports 20 manhours per report Annual reports 40 manhours per report
4. Granular Activated Carbon	3100.00	3100.00	13 GAC Contacters GAC replaced 2 times/year
TOTAL ANNUAL COST	29900.00	10700.00	Post remedial monitoring will be performed quarterly for years 1 thru 5 and annually for years 6 thru 30

AR301530

CROYDON TCE SITE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No. 3 (Sensitivity High Range)
Post Remedial Monitoring
(O&MCS3H)

Annual Costs

ITEM	ITEM $ QUARTERLY SAMPLING	ITEM $ ANNUAL SAMPLING	NOTES
1. Sampling	16800.00	4200.00	13 groundwater samples, 20 residential samples, 80 manhours per sampling period plus travel, living and sample shipping costs
2. Analysis	14000.00	3500.00	35 samples per sampling period (incl. blank and duplicate), volatile organic (EPA 601/SW 8010)
3. Reporting	3600.00	1800.00	Quarterly reports 20 manhours per report Annual reports 40 manhours per report
4. Granular Activated Carbon	4800.00	4800.00	20 GAC Contactors GAC replaced 2 times/year
TOTAL ANNUAL COST	39200.00	14300.00	Post remedial monitoring will be performed quarterly for years 1 thru 5 and annually for years 6 thru 30

CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No.2 (Baseline)
(PWAC32)
106

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	53.6											
2. O & M COSTS	---	3.4										
3. ANNUAL COSTS	53.6	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	54	3	3	3	3	3	3	2	2	2	2	2

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	2	2	2	2	2	1	1	1	1	1	1	1

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	3.4	3.4	3.4	3.4	3.4	3.4	3.4	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	1	1	1	1	1	1	1	106

AR301532

CROYDON TCE SITE
Bucks County, Pennsylvania
Connection to Public Water Supply
Alternative No.2 (Sensitivity High Range)
(PWACS2H)
121

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	69.1											
2. O & M COSTS	---	3.4										
3. ANNUAL COSTS	69.1	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	69	3	3	3	3	3	3	2	2	2	2	2

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	2	2	2	2	2	1	1	1	1	1	1	1

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	3.4	3.4	3.4	3.4	3.4	3.4	3.4	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	1	1	1	1	1	1	1	121

CROYDON .TE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No.3 (Baseline)
(PWACS3)
312

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	64.5											
2. O & M COSTS	---	29.9										
3. ANNUAL COSTS	64.5	29.9	29.9	29.9	29.9	29.9	10.7	10.7	10.7	10.7	10.7	10.7
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	65	28	27	26	25	23	8	8	7	7	7	6

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	6	6	5	5	5	5	4	4	4	4	4	3

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	10.7	10.7	10.7	10.7	10.7	10.7	10.7	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.256	.243	.231	
PRESENT WORTH =	3	3	3	3	3	3	2	312

AR301534

CROYDON . SITE
Bucks County, Pennsylvania
Granular Activated Carbon Domestic Water Treatment
Alternative No.3 (Sensitivity High Range)
(PWACS3H)
417

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	89.2											
2. O & M COSTS	---	39.2										
3. ANNUAL COSTS	89.2	39.2	39.2	39.2	39.2	39.2	14.3	14.3	14.3	14.3	14.3	14.3
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	89	37	36	34	32	31	11	10	10	9	9	8

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	8	8	7	7	7	6	6	6	5	5	5	5

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	14.3	14.3	14.3	14.3	14.3	14.3	14.3	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	4	4	4	4	4	3	3	417

EPA REGION III

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

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IMAGERY COVER SHEET
UNSCANNABLE ITEM

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OPERABLE UNIT OU1

SECTION/BOX/FOLDER Administrative Record - Section Volume III B - Fileroom

REPORT OR DOCUMENT TITLE Final Focused (FS) Report

DATE OF DOCUMENT 6/88

DESCRIPTION OF IMAGERY Monitoring well and Residential well - Sampling Locations & TCE Levels

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 Oversized Map